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THE WORM SNAKES OF THE GENUS LEPTOTYPHLOPS IN THE UNITED STATES AND NORTHERN MEXICO

BY

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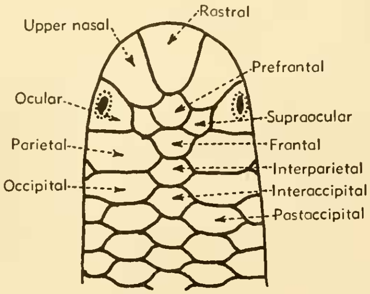

Fig. 1 Dorsal head scales.

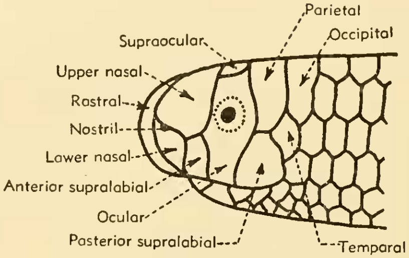

Fig. 2 Lateral head scales

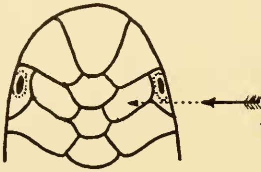

Fig. 3 *Albifrons* type of supraoculars.

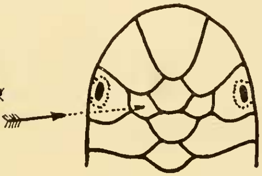

Fig. 4 *Dulcis* type of supraoculars.

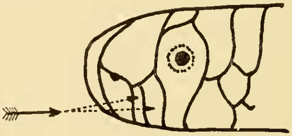

Fig. 5 Divided anterior supralabial characteristic of *dissectus*, *myopicus*, and *bressoni*.

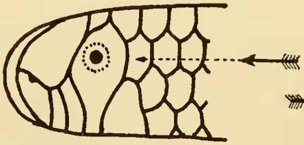

Fig. 6 Postocular scale characteristic of *bressoni*.

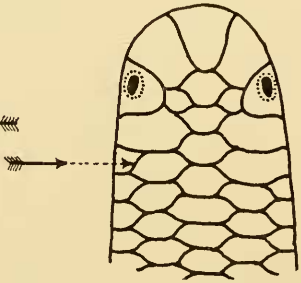

Fig. 7 Split in occipital (left side only) characteristic of *dissectus*.

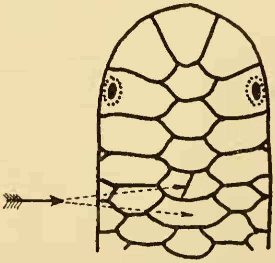

Fig. 8 Split interoccipital and widened fifth dorsal characteristic of *utahensis*.

Figures 1 to 8, Showing Scale Nomenclature and Specific Characteristics

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INTRODUCTION

Among the worm snakes of the genus *Leptotyphlops* collected in eastern San Diego County, California, in 1938, there was a single specimen with supraocular scales. This curious and unexpected find started the investigation, the results of which are here set forth.

Those who have not given particular attention to the worm snakes may well inquire why this specimen should be so startling. Neglecting subspecies for the moment, the current arrangement of the worm snakes allocates three species to our southern border from Texas to California: *L. dulcis*, *L. myopicus*, and *L. humilis*.[1] Of these, the first two have supraocular scales; the last is without them. Both *dulcis* and *myopicus* have been reported in southern Arizona, even as far west as Yuma.[2] What could be more logical than to add a mere 100 miles to a range already known to extend 1100 miles westward from central Texas? But the solution is not so simple, for this puzzling specimen has a higher dorsal scale count, by about 40, than any other specimen of *dulcis* or *myopicus* hitherto found. And this high scale count is near the average of the specimens of *humilis* found in the same locality as this queer individual. Thus we either have a new species, turning up in an area which has been quite thoroughly collected, or an aberrant specimen with an anomalous pair of scales of a character often considered of generic or subgeneric importance.[3]

Naturally the solution of this problem led to a search for other characters differentiating *dulcis* from *humilis;* for the repetition of other *dulcis* characters in this specimen would have confirmed its separation from *humilis*, notwithstanding the improbability of a new species coming so unexpectedly to light. This led to the preparation of a schedule of some sixty worm snake characters (many of which later proved to have little signficance) and the checking of a number of specimens with respect to each of these characters. Gradually it became necessary to widen the scope of the inquiry, for each conclusion in turn disclosed new problems; until finally it appeared advisable to survey all the species of *Leptotyphlops* allied to *L. dulcis* and *L. humilis* in the United States, and northern and central Mexico.

In the latter territory there is an overlap with forms not belonging to the *dulcis-humilis* complex, such as *L. phenops*, *L. bakewelli*, and possibly other species allied to *L. albifrons*. The *albifrons* group is largely tropical, being found in greatest profusion in Central and South America; it falls beyond the scope of the present paper, although a brief survey was made of these tropical forms in order to become familiar with their characteristics. There are non-*albifrons* worm snakes of the genus *Leptotyphlops* in South America—*septemstriatus* and *macrolepis*, for example. Whether additional material will eventually show these to be linked with the *dulcis-humilis* group in North America I cannot say, although the similarity of one of the Mexican forms to another in South America suggests such a possibility. At present there is a considerable territorial gap between the two non-*albifrons* groups, for the southern limit of the *dulcis-humilis* complex is at about Lat. 17° N., where *maximus* is found, and non-*albifrons* snakes have not yet been collected anywhere in Central America.

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[1] Taylor, 1939, p. 1; Stejneger and Barbour, 1939, p. 93.

[2] Van Denburgh and Slevin, 1913, p. 409.

[3] Stejneger, 1891, p. 501; Klauber, 1931, p. 335.

While *albifrons* forms occur on both Mexican coasts as far north as Lat. 19° N., so that there is a wide territorial overlap between the *dulcis-humilis* and *albifrons* groups, there is little difficulty in segregating them, since the two have several differences, amongst which may be listed the following:

Albifrons Group	*Dulcis-humilis* Group
Supraoculars attenuated, about twice as long as wide, larger than the prefrontal or frontal (fig. 3).	Supraoculars, if present, lunar in shape, about the same size as the prefrontal or frontal (fig. 4).
A conspicuous and sharply contrasting white spot on the snout and on the tail tip.	No sharply contrasting white spot on the snout or tail tip.
Dorsal scales usually light-edged, producing longitudinal light lines on a dark brown background.	Dorsal color from dark brown to white, but without longitudinal light lines.
Ventral surface darkly pigmented with brown and often with longitudinal light lines.	Ventral surface tan, pink, or white, with little or no dark pigmentation.

I think that, although an occasional form may deviate from this schedule with respect to one of these characters, enough will remain apparent to render segregation easy, at least in Mexico. Further south, in Central and South America, and in the Caribbean islands, there may be species which do not so clearly fall either into the *albifrons* or the *dulcis-humilis* group. Possibly a third group, or subgenus, is involved.

LIST OF SPECIES AND SUBSPECIES TREATED

I now return to the *dulcis-humilis* group, as found in the southwestern United States and northern Mexico, to which the present study is limited. I recognize as valid the following species and subspecies:

A. With supraoculars
    - *Leptotyphlops dulcis dulcis* (Baird and Girard), 1853
    - *Leptotyphlops dulcis myopicus* (Garman), 1883
    - *Leptotyphlops dulcis dissectus* (Cope), 1896
    - *Leptotyphlops maximus* Loveridge, 1932
    - *Leptotyphlops bressoni* Taylor, 1939

B. Normally without supraoculars
Leptotyphlops humilis humilis (Baird and Girard), 1853
Leptotyphlops humilis dugesii (Bocourt), 1881
Leptotyphlops humilis tenuiculus (Garman), 1883
Leptotyphlops humilis slevini Klauber, 1931
Leptotyphlops humilis cahuilae Klauber, 1931
Leptotyphlops humilis utahensis Tanner, 1938
Leptotyphlops humilis segregus Klauber, 1939

I would place the following in synonymy:
Stenostoma rubellum Garman, 1883: synonym of *L. d. dulcis*.

HISTORICAL TAXONOMIC SUMMARY

The genus *Leptotyphlops* was established in 1843 by Fitzinger (Systema Reptilium, p. 24), on the South African species *nigricans*. The snakes of the family *Leptotyphlopidae*, usually called worm snakes, differ from the blind snakes of the family *Typhlopidae* in that the former have teeth in the lower jaw only, while the latter have only maxillary teeth. The worm snakes are widely dispersed in Africa, southwestern Asia, and the Americas.

Of the American forms coming within the scope of the present paper, the first was described by Baird and Girard in 1853 (Cat. N. Amer. Rept., Pt. 1, p. 142). They set up the new genus *Rena* for the species *dulcis* and *humilis;* thus *Rena* was broad enough to include snakes both with and without supraoculars.

In 1857, Peters (Monatsber. Acad. Wiss. Berlin, p. 402), when describing two new South American species, considered *Rena* a synonym of *Stenostoma,* although he did not mention the Baird and Girard species by name. *Stenostoma* had been set up by Wagler in Spix, Serp. Bras., 1824, p. 68, for the species *albifrons*.

In 1890, Boulenger (Fauna of British India, 1890, p. 243) showed that *Stenostoma* was preoccupied, as was also *Catodon* Duméril and Bibron, 1844, which French herpetologists had employed for this genus of worm snakes. Boulenger therefore returned to the genus *Glauconia* of Gray, 1845, genotype *nigricans*.

In 1891, Stejneger (Proc. U. S. Nat. Mus., Vol. 14, p. 501) pointed out that *Leptotyphlops* of Fitzinger, 1843, was two years older than *Glauconia,* and therefore should take precedence over the latter. However, he applied *Leptotyphlops* only to the species with supraoculars, returning *humilis* to *Rena* of Baird and Girard, 1853. Van Denburgh in 1897 (Occ. Pap. Calif. Acad. Sci., 5, p. 150) considered *Rena* inapplicable to the snakes without supraoculars, since it was first applied (by page priority) to *dulcis;* he therefore adopted *Siagonodon* of Peters, 1881, genotype *septemstriatus* of South America, for this group. Bocourt had used *Siagonodon* for a Mexican form without supraoculars (*dugesii*), as early as 1882.

In 1907, Ruthven (Bull. Am. Mus. Nat. Hist., Vol. 23, Art. 23, p. 573) stated that he did not feel *dulcis* and *humilis* to warrant generic differentiation and placed both in the genus *Leptotyphlops*. Since then this view has had increasing adherence among herpetologists, and is now almost universally adopted. The writer suggested in 1931 that the presence or absence of supraoculars might be given subgeneric recognition, those without supraoculars being referred to the subgenus *Siagonodon.*

The following is a brief chronological outline of the specific names which have been applied to the worm snakes of the United States and northern Mexico:

Dulcis was the first species described; this was based on a specimen in the Smithsonian Institution (No. 7296) collected on the Mexican Boundary Survey, by J. H. Clark, and sent in by Col. J. D. Graham. Neither the exact date nor the locality of collection is known; the latter is given as between San Pedro and Comanche Springs, Texas. The description, by Baird and Girard, appeared in January, 1853, in their "Catalogue of the North American Reptiles in the Museum of the Smithsonian Institution. Part I.—Serpents" at page 142.

In the same paper (p. 143) appeared the description of *humilis*, founded on a specimen (No. 2101) collected by Dr. John L. Le Conte at "Valliecitas," California, in 1850. The actual type locality is doubtful (Klauber, 1931, p. 343); the color of the specimen indicates that it came from the coastal, rather than the desert side of the mountains.

The first specimens to come from beyond the presently assigned ranges of *dulcis dulcis* or *humilis humilis* were *humilis* from the vicinity of Yuma, Arizona, and from the Cape Region of Lower California, as mentioned by Cope (1861, p. 305). The Yuman specimens were probably those which have since been assigned numbers 12064 and 12065 in the collection of the Academy of Natural Sciences of Philadelphia; the latter are a pair in the U. S. National Museum (No. 5292), collected by John Xantus at Cape San Lucas, Lower California. In 1931 the present writer assigned the subspecific name *humilis cahuilae* to the Yuman form, and *h. slevini* to that from the Cape, using, however, more recently collected specimens as the types (Klauber, 1931, p. 338).

In 1879, in his Eleventh Contribution to the Herpetology of Tropical America (Proc. Am. Philos. Soc., Vol. 18, p. 262), Cope listed a specimen of *humilis* from Batopilas, Chihuahua, collected by Dr. Edward Wilkinson. This was the first mention of this species in mainland Mexico. Two years later, F. Bocourt, in Bull. Soc. Philom. (7) 5, p. 81, described this Mexican form as *Catodon Dugesii,* founded on a specimen collected by Dr. Alfred Dugès in Colima, Mexico. I now consider this to be a valid subspecies, *L. humilis dugesii.*

In 1883, Garman (Mem. Mus. Comp. Zool., Vol. 8, pp. 5-6) described three new species of worm snakes, following his study of the material in the Museum of Comparative Zoology at Harvard University. These were *Stenostoma rubellum, S. tenuiculum,* and *S. myopicum. Rubellum,* type MCZ 4584, collected by Dr. Edward Palmer at Uvalde, Uvalde County, Texas, in 1880, is clearly a synonym of *dulcis* Baird and Girard, 1853; it was described by Garman as a result of misinformation on the type of *dulcis.*[4] *Tenuiculus* is founded on MCZ 4519 collected by Dr. Edward Palmer in San Luis Potosí, Mexico, in 1879. It is without supraoculars and therefore allied to *humilis,* of which recent herpetologists have considered it a synonym.

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[4] Stejneger, 1891, p. 501; Taylor, 1939, p. 4.

Garman's third species was *myopicus,* the first North American species having a split anterior supralabial to be described. The cotypes are three in number (MCZ 4526) collected by Dr. Edward Palmer, at Savineto, near Tampico, Tamaulipas, Mexico, in 1879.

Cope in 1894 (Am. Nat., Vol. 30, p. 753) described an allied subspecies under the name *Glauconia dissecta,* from a specimen in the collection of the Philadelphia Academy, collected at the silver mines near Lake Valley, Sierra County, New Mexico. While currently considered synonymous with *myopicus,* I find the specimens from New Mexico and farther north to show some differences from those from Mexico, leading to the reinstatement of *dissectus* as a separate subspecies. Cope had listed this type specimen (which he himself collected) as early as 1883, under the name *Stenostoma dulce,* probably the first mention of a snake of the genus from New Mexico.

Nearly forty years elapsed before additional forms came to light or were recognized. In 1932 Loveridge (Proc. Biol. Soc. Wash., Vol. 45, p. 151) described *maximus,* based on four specimens (MCZ 33,604–7) collected by W. W. Brown in 1932 at Chilpancingo, Guerrero, Mexico.

Specimens from Utah were first reported by Tanner in 1935, as *Siagonodon humilis;* in 1938 (Proc. Utah Acad. Sci. Arts and Letters, Vol. 15, p. 149), he described these as a new subspecies, *utahensis.* The type specimen, BYU 662, was collected at St. George, Washington County, Utah, by V. M. Tanner and A. Paxman, April 28, 1938.

Two new forms were described in 1939. The first is *L. bressoni* Taylor, founded on a unique specimen in the Taylor-Smith Collection (No. 5247) collected by J. R. Bresson at Hda. El Sabino, Uruapan, Michoacán, Mexico. The second is *segregus,* described by the writer to cover the eastern form of *humilis,* having only 10 scale rows around the tail. The type is USNM 103,670, collected on Chalk Draw, Brewster County, Texas, August 11, 1936, by T. F. Smith. The first Texas specimen without supraoculars mentioned in the literature was AMNH 8596, collected by Major Chapman Grant at Fort Clark, Kinney County, (Schmidt, 1922, p. 683). *Segregus-humilis* intergrades from Tucson were listed in catalogues even earlier; but, as this is an area of intergradation between *humilis* and *segregus,* it is impossible to determine the first mention of a pure *segregus* from that vicinity.

SCALE NOMENCLATURE

(Figs. 1 to 8)

While there have been no extensive differences of opinion concerning the nomenclature to be applied to the scales of *Leptotyphlops,* there are some which require definition, since authorities have not always agreed on consistent appellations.

In the following discussion the dorsal scale count has been taken as beginning with the prefrontal and concluding with the scale just anterior to the tail spine. Similarly, the subcaudals begin with the first scale in the mid-ventral row, posterior to the anal, and conclude with the scale anterior to the terminal spine.

The scales of the supralabial series are normally in the following order:

(1) a nasal (or an inferior nasal, if the nasal be divided by a suture through the nostril, as is usually the case); (2) an anterior supralabial; (3) an ocular; (4) a posterior supralabial. In some forms, as, for example, *myopicus, bressoni,* and *macrolepis,* the anterior supralabial is divided vertically, and it has been customary to refer to the two halves as two supralabials, which, of course, they are. However, this causes the posterior supralabial to become the second in some forms and the third in others. Also, this numbering is confusing, in that the inferior nasal and the ocular are also supralabials; indeed they are sometimes called naso-labials and oculo-labials. I think it best to consider the true supralabials as anterior and posterior, and to refer to the anterior in such forms as *myopicus, macrolepis,* and their relatives as being split, or divided vertically, into a first and second half (fig. 5). Thus the condition of the anterior supralabial does not affect the terminology of the posterior.

The mid-dorsal series, beginning with the first scale back of the posterior tip of the rostral, comprises successively: (1) a prefrontal; (2) a frontal; (3) an interparietal; and (4) an interoccipital. Although I employ the customary nomenclature for these scales, it should be pointed out that some confusion may result from the fact that the so-called frontal is really between the parietals, and the interparietal often has a more extensive contact with the occipitals than with the parietals.

The first large scale posterior to the ocular on each side has been variously referred to as a parietal, an anterior parietal, or a postocular; and the second large scale as an occipital or a posterior parietal. I prefer the terms parietal for the first, and occipital for the second, as being least confusing. If a scale intervenes between the parietal and the posterior supralabial (as in *bressoni*) it should be called a postocular (fig. 6). The scale which is normally between the occipital and the posterior supralabial is the first temporal. If the scales posterior to the occipitals are enlarged they are referred to as postoccipitals.

As E. H. Taylor has pointed out (1939, p. 6) it is necessary to open the mouth to see the true posterior infralabials, because of the overhang of the upper jaw. In any case, the scales on the lower jaw, including the mental and infralabials, are so small and with such faint sutures, that they are counted with difficulty.

DIFFERENTIAL CHARACTERS

Before discussing the species and subspecies into which the *dulcis-humilis* group may be divided, I desire to present certain general data on the differential characters which may be used in segregating the several forms. The problems of classification in the worm snakes of the family *Leptotyphlopidae* are quite different from those involved in most other families, such as the *Colubridae* and *Crotalidae,* with which we are accustomed to deal. The scale formulas and arrangements in the worm snakes are relatively simple; the lack of formal pattern and diversity of color, the cylindrical shape, and the small size all tend to reduce or obscure the differences between species.

The characters which may be found useful in classification are as follows:

A. Size
B. Body proportions
    1. Ratio of length to diameter

    2. Ratio of length over-all to tail length
- C. Scale series which can be counted
    1. Scale rows around body
    2. Scale rows around tail
    3. Number of scales in the median dorsal row
    4. Number of subcaudals
- D. Presence or absence of specific scales; division of scales; contacts or arrangements between scales; relative sizes and configurations of scales
- E. Pattern and color

While worm snakes are not particularly rare, and, in fact, may be quite common in many places, they are so small and secretive that they are not well represented in most herpetological collections. Large homogeneous series, therefore, from restricted areas are not usually available. Hence we are often handicapped in determining the value of differential characters by an inability to secure adequate series wherewith to test the extent of intraspecific variation and dispersion, upon which we must base the validity of species differences. For it must be obvious that we cannot judge the significance or importance of apparent differences between a pair of hypothetical species or subspecies, unless we have some knowledge of the extent of variation to be found within each species separately. If we do not have these data, what are at first supposed to be important differences between species, or between subspecies occupying separate ranges, may, with more adequate material, be found to be within the range of variation of a single homogeneous population; that is, the supposed distinctions may be only the result of the chance differences between the first samples available to us.

I have been fortunate in securing a few fairly good series (50 or more specimens) from two or three restricted areas, within which the constancy of ecological conditions should lead one to expect no racial variations, even in so small and slow moving a form as *Leptotyphlops*. Dispersion studies have been made in these groups and from these we may assign certain weights to the differential characters, based on their variations within the homogeneous groups. We cannot, of course, be sure that the same characters will have the same degrees of variation in other species; nevertheless in other families and genera (the rattlesnakes for example) it has been found that there is considerable constancy in the relative dispersions of characters throughout a genus. For example, in a number of species and subspecies of rattlesnakes the coefficients of variation of several characters were found to fall within the following rather narrow ranges:

Character	*Coefficient of Variation in Per Cent*
Scale rows	3.0 to 5.1
Ventrals	1.7 to 3.0
Subcaudals	5.7 to 9.3
Supralabials	5.6 to 6.6
Infralabials	5.6 to 6.6
Body blotches	5.9 to 8.6
Tail rings	12.2 to 22.8

If two forms of rattlers are to be differentiated, of which few specimens are available, we may not be justified in assuming a coefficient of variation in any character wherewith to check the significance of the differences; yet certainly this table, resulting from studies of large series of the more common species, would lead us to place more dependence on ventral differences than in tail rings, for the latter are shown to have a relatively wider dispersion. Similarly, in the worm snakes, a study of a few common forms may afford a useful measure of the probable validity of differences between the rarer species.

One handicap of the student of the worm snakes lies in the difficulty of ascertaining the sex of each specimen, this being usually so difficult that sex differentiation must be neglected. In other families, tail-length ratios, ventrals, subcaudals, and often other characters, are sexually dimorphic; so that intraspecific dispersions are reduced when the sexes are segregated. This division cannot be made in studying the worm snakes. I do not know whether body proportions, or dorsal or subcaudal scale counts, are different in male and female worm snakes. Possibly some of the dispersions which we find would be reduced if such a sexual segregation could be made.

Another worm snake difficulty is inherent in their small size, which makes the accurate counting of scales difficult. This is particularly the case where the scales are light colored and shiny, or where the specimen is poorly preserved. I have no doubt that some of the dispersions which we find result from simple inaccuracies in the data.

We now return to a discussion of the several differential characters previously mentioned.

Size

Although there is no question as to the considerable differences in the sizes of worm snake species, this is not a particularly useful character, in segregating closely related forms, for, unless large series are available, we cannot be sure that we have a good idea of the maxima and minima. We cannot readily distinguish juveniles from adults, so that average adult sizes are difficult to determine, except in large homogeneous series.

The largest American species, as far as now known, is *L. humilis*. This reaches a maximum in the desert subspecies *L. h. cahuilae*, in which specimens exceeding 350 mm. are not unusual and one measuring 389 mm. has been noted. On the desert slope of the Peninsula Range in southern California intergrades which have some characteristics of both *L. h. humilis* and *L. h. cahuilae* attain a length of at least 325 mm. In western Texas *L. h. segregus* reaches 320 mm. at least. Neither *dulcis* nor *dissectus* is so large.

Body Proportions

The ratio of the body length over-all to the diameter, and of the body to the tail length, are useful characters, but they must be employed with caution. The difficulty of accurate sexing renders it impossible to eliminate the effect of sexual dimorphism if there be any; and we must be wary of both intraspecific dispersion and ontogenetical variation. Care must be taken that the method of preservation used on the several specimens has not differed to such an extent as to affect the data, particularly the body diameter.

To determine the extent of intraspecific dispersion and ontogenetical variation in a typical worm snake we take, as an example, the coastal-slope specimens of *L. h. humilis* from San Diego County, apparently a homogeneous series.

We have the following data on the ratio of body length to diameter:

Limiting Ratios	*Number of Specimens*
Under 45	1
45 - 50	11
50 - 55	15
55 - 60	13
60 - 65	9
65 - 70	2
Over 70	1
	52

Thus we see that the range 45 to 65 covers most of the specimens; the few falling outside of this range may result from inaccurate measurements or distortion in preservation. We would not go far wrong in saying that this subspecies averages about 55, that most of the specimens will fall within ten points on either side, and that half the specimens will fall between 50 and 60.

Some of my correspondents have expressed doubt as to the value of this character in differentiation, because of the obviously high intrasubspecific variation. In the San Diego specimens (using adults above 200 mm. only) the coefficient of variation of the ratio was found to be 11 per cent. Assuming that this is a fair value derived from homogeneous populations, with specimens well preserved and carefully measured, and that the dispersion of the ratio is approximately normal, what difference must be shown between the means of two samples in order that the difference may be considered significant, is being further agreed that the significance level is taken at $P=0.05$?

We find that, with 10 specimens of each form available, if one form averages $L/D=50$, the average of the other must be about 6 higher or lower, that it, the mean of the second species must be less than 44 or more than 56 to be significantly different. If about 25 specimens of each form be available and the ratios are about 50, then one must be at least 3.3 greater or less than the other to be significant, at the level specified. This gives an idea of the differences which must be in evidence to demonstrate significance. Of course, if the coefficients of variation in this character tend to run higher than 11 per cent, then larger differences must be evident before significance (at the level of $P=0.05$) would be indicated. With moderately plentiful specimens, say above 20 adults of each form, this character is well worth investigation. Undoubtedly there are often real differences between species of *Leptotyphlops* and occasionally even between subspecies. However, if few specimens are available the ratio is of little practical use, unless the mean difference between the samples be very wide. Since there are likely to be ontogenetical variations in any ratios of this type, only adults should be used in the comparative statistics.

For example, in the San Diego County *humilis humilis,* if we plot, on rectangular co-ordinates, diameter against body length, we find that the regression line seems to be parabolic, rather than straight, the x^2 term being positive. Thus, speaking ontogenetically, larger specimens tend to be somewhat thicker proportionately than younger specimens; worm snakes become somewhat less attenuated as they age. The scatter is such that I would hesitate to put the relationship into mathematical terms until at least 200 or more specimens become available from this area.

With regard to the tail length, in the same collection of San Diego County *humilis,* the dispersion of the ratio of the length over-all to the length of the tail is indicated by the following table:

Limiting Ratios	*Number of Specimens*
Under 16	1
16 – 18	5
18 – 20	17
20 – 22	19
22 – 24	9
Over 24	3
	54

We see that over half the snakes fall between 18 and 22. The coefficient of variation is found to be 9.5 per cent. This gives an idea of the deviation which would have to be shown between two species to indicate a significant difference. In the direction of the regression line, there is an indication of a slight reduction of proportionate tail length with growth.

Scale Series

The scale rows around the body are constant at 14 in the American forms of the genus as presently known. Any deviate is likely to be merely a freak. Only one (with a count of 13) was found in over 400 specimens, this being a *humilis-cahuilae* intergrade, a peculiarly variable group.

The number of scale rows around the tail has proved to be a useful character, permitting the segregation of forms hitherto thought alike. In any specific area the constancy of this character seems demonstrated, intergradation having been found only between two subspecies in Arizona. In the group here studied there are always either 10 or 12 scale rows around the tail; if the former be the case, there is another, possibly countable character, in the number of scales in advance of the anus at which the first reduction from 14 to 12 takes place. The second reduction seems always to be effected at the base of the tail.

The number of scales in the median dorsal row is probably the most important single character. In American *Leptotyphlops* the variation is from about 200 to 330. Except in the smallest specimens, or those which are badly dried out, the count can be made with fair accuracy; several observers will rarely differ by more than a scale or two. It is best to standardize on the prefrontal as the first scale to be counted, and stop with the last flat scale anterior to the tail spine. Tiny pins will be found useful in marking stations along the way, so that if the count be lost one will not have to return to the beginning.

The subcaudals are not as easy to count, although, being so limited in number, they take but a moment. However, they are difficult to see, if the tail is colorless, as is so often the case; and occasionally there is a scale at the beginning or end of the series, the inclusion of which will be doubtful. In particularly important cases the specimen may be brushed lightly with the point of an indelible pencil and then wiped with a cloth. The purple color will follow the scale boundaries and make them clearly evident; it will disappear when the specimen is returned to the preservative.

The extent of the dispersion of these two scale characters is indicated by the following statistics of the three largest available geographically-concentrated series, namely: (1) cismontane *humilis humilis* from San Diego County; (2) transmontane *humilis* from San Diego County (these are either *cahuilae* or *humilis-cahuilae* intergrades); and (3) *dulcis dulcis* from Bexar and Atascosa Counties, Texas.

CHARACTER	CISMONTANE *humilis*	TRANS-MONTANE *humilis*	TEXAS *dulcis*
Number of specimens	56	40	28
Dorsals			
Extreme range	257–283	280–305	209–247
Interquartile range	267.8–276.2	289.5–297.5	223.1–237.2
Mean[5]	271.98∓0.83	293.50∓0.93	230.14∓1.98
Standard deviation	6.21	5.88	10.48
Coefficient of variation, %	2.28	2.00	4.55
Subcaudals			
Extreme range	15–21	15–21	13–17
Interquartile range	16.9–18.8	16.4–18.3	13.9–15.4
Mean[5]	17.86∓0.20	17.34∓0.24	14.67∓0.21
Standard deviation	1.41	1.46	1.07
Coefficient of variation, %	7.90	8.42	7.29

Neglecting for the moment the dorsals of the Texas group, we find that dorsals and subcaudals have coefficients of variation somewhat similar to those found for ventrals and subcaudals in the rattlesnakes. Similar percentages occur among representative colubrines, although in the latter family the subcaudals are likely to show even lower coefficients of variation (especially after segregating the sexes), since the tails are longer and more functional than among the rattlers and worm snakes. For example, in a large series of *Lampropeltis getulus californiae* from San Diego County the coefficient of variation of the subcaudals was about 5½ per cent, a lower figure than that of the rattlers or worm snakes; but the king snake ventrals had a coefficient of about 2.1 per cent, substantially the same as the rattlers and worm snakes.

Thus we have, in the dorsals and subcaudal scales of the worm snakes, two useful characters—especially useful because they are countable and therefore not subject to personal differences of interpretation. Also, they may be handled statistically and we may compute, rather accurately, the significance of the difference between any two groups; that is, the likelihood that any observed difference results merely from the chance composition of the samples available, rather than from a real difference between the populations which the samples are presumed to represent. But, of course, any proof of difference does not automatically indicate whether the difference is subspecific, specific, or generic; these are ill defined terms, and the final application of the ascertained difference rests with the temperament of the worker. With large series, especially in the case of snakes and lizards, which have so many countable (rather than measurable) characters, it is easy to find many differences between geographically separated populations, which differences are real and definite but do not warrant nomenclatorial recognition by subspecific separation. But they are interesting in demonstrating the presence of trends and incipient speciation. Small samples require relatively much larger differences to prove that the observed deviations are not to be attributed to chance.

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[5] The use of the sign ∓ rather than ± indicates that the following figure is the standard and not the probable error of the mean.

The actual use of the dorsals and subcaudals, in determining the validity of differences between worm snakes, may be illustrated by employing the statistics already given. The dispersions are unimodal and, in fact, substantially normal, so that we can use the simple formula involving the ratio of a difference to its standard error, interpreting the result in terms of the probability that the basic populations are the same or different.

We find that, with respect to the two San Diego County subspecies, their difference in mean dorsal scale counts is highly significant, while that of the subcaudals is not, there being about 9 chances in 100 that the difference in the latter merely results from the particular composition of the samples. But the difference between the subcaudals of the cismontane snakes from San Diego County and those from Texas is highly significant, for there is less chance than one in a million that so large a difference could be found in two samples of this character selected at random from the same population.[6] Thus it is indicated, with these examples of dispersion in specific forms, that the dorsal and subcaudal scale counts in the worm snakes have a value in separating species or subspecies, on a par with similar characters in better known families.

It will be observed that I have neglected the dorsal scale counts of the Texas specimens from Bexar and Atascosa Counties. I am disturbed by the high value of the coefficient of variation shown in this character—so much higher than the same coefficient determined from the San Diego specimens. This is even evident in the difference of the extremes, $247-209=38$, as compared with extreme differences of 28 and 25 in the two San Diegan groups. I do not consider extremes of great importance, since they result too often from individual abnormalities, or even simple miscounts; nevertheless, in this instance they show the same tendencies as the much more important measures involved in the standard deviations and coefficients of variation.

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[6] The number of specimens in the Texas sample is rather small for the use of this simple formula; but the difference is so great that the probability is only slightly changed by using the more accurate *t*-test, which is necessary when the samples are small.

This peculiarity in the Texas specimens cannot result from ecological variations, for the cismontane snakes in San Diego County are subject to much greater differences than exist in these two Texas counties. Furthermore, the same situation holds in another pair of Texas counties, and in Texas as a whole; although the latter case, because of the great area thus included, might be attributed to geographical variation. We have the following statistics, the Bexar-Atascosa figures being repeated for the sake of clarity:

Character	Bexar-Atascosa Counties	Bosque-McLennan Counties	All Texas
Number of specimens	28	29	108
Dorsals			
Extreme range	209–247	213–241	207–255
Interquartile range	223.1–237.2	217.5–228.7	221.1–234.6
Mean	230.14∓1.98	223.10∓1.55	227.84∓0.96
Standard deviation	10.48	8.36	10.01
Coefficient of variation, %	4.55	3.75	4.39
Subcaudals			
Extreme range	13–17	12–16	12–17
Interquartile range	13.9–15.4	13.8–15.2	13.8–15.3
Mean	14.67∓0.21	14.50∓0.20	14.56∓0.11
Standard deviation	1.07	1.04	1.11
Coefficient of variation, %	7.30	7.17	7.63

Thus we see that the dispersion of the dorsals is consistently high in Texas *dulcis* as compared to San Diego County *humilis*. Comparisons with other smaller groups of worm snakes from several areas seem to bear out the same conclusion. The dispersion of the dorsals in the Texas specimens is higher than is to be expected unless this species is unaccountably variable in this area. The other obvious possibility—that there are really two species which are being confused, because of their external similarity—has been canvassed without result. I have looked for differences between the snakes having the highest and lowest dorsal counts, thus far in vain. A correlation between size and dorsal scale counts showed promise, but eventually broke down; most, but not all, of the largest specimens have dorsal counts well above the average. Despite the negative results, I am not convinced; I think that some future observer may find that there are really two species of worm snakes in Texas, at present lumped into the single subspecies *L. dulcis dulcis*.

As to the shape of the frequency distributions of dorsals and subcaudals, the Texas series of *dulcis dulcis* is the only one from which even the most tentative decision may be drawn. The dorsals are too scattered, however, to draw a conclusion with any certainty; the distribution seems to be platykurtic, but not definitely skewed. This may be a significant hint with respect to the answer to the question previously raised as to the possibly composite character of the subspecies.

The subcaudals of these Texas specimens have the following distribution: 12–2, 13–18, 14–32, 15–33, 16–20, 17–3, the first number in each case being the number of subcaudals, and the second the frequency of occurrence of that number. This is probably a normal distribution, as shown by a chi-square test; using the ordinate method, as appropriate for discrete variates, the result is $P=0.56$, or more than an even chance that a distribution as divergent from normal as this sample, might have been drawn from a normally distributed population.

Scale Configurations

In spite of the simplicity of the scale arrangements in these worm snakes, a large number of modifications, and combinations of such modifications, are possible. Scales may be present or absent; some may be sutured; there may be unusual arrangements or contacts; changes in relative sizes and configurations may be evident. It is the purpose of this discussion to point out the repetitious character of some of these modifications, amongst forms only remotely related, the frequency of aberrants, and the possible effect of these conditions on the validity of newly described species and subspecies. Again we have, first, the statistics of the significance of differences, followed by the individual and personal interpretation of those differences into taxonomy.

I have already mentioned the presence of supraoculars in a specimen of *L. humilis cahuilae* (LMK 28,839) a subspecies which is supposed to have none. Another specimen (LMK 30,567) has a supraocular on the left only. This is a most important scale, upon whose presence or absence taxonomic decisions are made, and thus it is shown to be not always true to form. Another important character is the vertical splitting of the anterior supralabial which characterizes *myopicus* and *dissectus*. This is repeated in Venezuela in *macrolepis*, and in *bressoni* in Mexico. The contact between the anterior and posterior supralabial which characterizes *bilineatus* of the Lesser Antilles occurs on one side of a specimen of *humilis* from Cedros Island in the Pacific. The presence of a postocular, preventing the contact of the parietal with the posterior supralabial, which is characteristic of *bressoni*, is also evident on one side of a specimen of *segregus*. A specimen of *dissectus* from near Tulsa has a split interoccipital; this is characteristic of *utahensis*. In one of a pair of specimens of *phenops* from Tehuantepec the rostral is fused to the frontal, as in *bakewelli*, but the other is without this fusion. A *dulcis-myopicus* intergrade from Cerro Potosí, Nuevo León, has a suture in the forward part of the ocular, which is the beginning of a second anterior supralabial; this is the character upon which Brongersma described *L. ihlei*, a relative of *macrolepis* from Surinam. Various other fusions are occasionally evident. Thus in LMK 31,849, from Scissors Crossing in San Diego County, the anterior supralabials are fused to the oculars, which in turn meet on the mid-dorsal line. In another, from the same area, the nasals contact between the rostral and prefrontal on the mid-dorsal line. A specimen of *dulcis* has the lower nasal divided vertically at the nostril, while another has an extra pair of scales between the rostral and prefrontal.

Similarly there are to be noted, even within a subspecies, considerable variations in scale configurations, such as the shape of the ocular and the position of the eye; the height of the anterior supralabial relative to the eye; the location of the posterior tip of the rostral relative to the eye; the size and shape of the anterior supralabials; the shape of the supraoculars; and the relative sizes of the first four scales in the mid-dorsal series.

But with all these abnormalities and repetitions, in forms which are only distantly related, of peculiar contacts and arrangements, I would not be understood as minimizing the validity of these characters in distinguishing and segregating species and subspecies. I wish merely to point out that it is hardly safe to segregate a new form premised on a single character in one specimen. It is much better to wait until several specimens are available to see whether the character is consistent within a certain area. And if the character is not universally present in the new form, its importance should be demonstrated by the use of a contingency table. If several differences from the nearest relative can be found in a single specimen, then it is much safer to describe such a form as new.

Pattern and Color

While the worm snakes usually lack the variegated and brilliant patterns and colors typical of so many snakes, nevertheless there are specific and subspecific differences, some of a high degree of consistency, so that color and pattern may be of importance. In the *albifrons* group, for example, we have the characteristic longitudinally striped dorsum and the white spots on head and tail. The latter vary markedly in position and extent, and such variations may be of subspecific importance.

The *dulcis-humilis* colorations are not so striking, yet they are of equal importance in separating species and subspecies. Usually both the hue and the number of dorsal scale rows to which it is applied are involved; for in some forms only 5 rows are affected, while in others this increases to as many as 9, although 7 is more general. The dorsal color may vary from dark brown through gray to cream or white. There may be a strong or a weak contrast between the dorsal and ventral colors; and there may be a sharp or a gradual transition from the one to the other. The ventral color is usually buff, cream or white, although brown spots are sometimes present on the chin-shields and anal plate.

These color notes are only applicable to preserved specimens. Live specimens are so transparent that they all have a pinkish or purplish cast, differences which are very apparent after preservation being hardly noticeable. So, in color studies, the worm snakes are better considered preserved than alive; while the contrary is true of most other families, since preservation quickly removes certain bright colors, particularly the reds and yellows. With worm snakes, although the preservative has a tendency to bring out important color differences which otherwise would not be apparent, it is desirable to have a uniform method of preservation, so that comparisons can be fairly made. Also, it is necessary with these snakes, as with others, to store them in the dark to avoid fading.

As an example of the effect of preservative in accentuating color differences, we take typical specimens of *L. h. humilis* and *L. h. cahuilae*, alive and preserved. The colors referred to are those of Ridgway, 1912. A glance at the color plates will show the lack of contrast between dorsum and ventrum, and also between the dorsal colors of *humilis* and *cahuilae* in life, and the correspondingly strong contrasts after preservation.

	Before Preservation	
	Humilis	*Cahuilae*
Dorsum	Indian purple	Light purplish vinaceous
Ventrum	Pale vinaceous lilac	Pale brownish vinaceous
	After Preservation	
Dorsum	Natal brown	Pale olive buff
Ventrum	Tilleul buff	Between pale olive buff and white

PROBLEMS INVESTIGATED

The present investigation was undertaken primarily with a three-fold purpose: To determine the possibility of *dulcis* and *humilis* being a single species, as suggested by the finding of specimens with supraoculars in San Diego County; to investigate the relationship of *dulcis* and *myopicus* (or *dissectus*); and, finally, to study the validity and relationships of some of the subspecies which have been proposed.

Dulcis-humilis Relationship

Worm snakes are found both with (*dulcis*) and without supraoculars (*humilis*), from southeastern Arizona eastward to the vicinity of Fort Clark, Texas. In fact, *dulcis* has been reported to occur both at Yuma and Tucson, Arizona, but the specimens upon which these records were based are no longer available. However, specimens of both forms are now at hand from various points along our southern border from the Huachuca Mountains of Arizona to Fort Clark, in western Texas.

Were there specimens of both forms, retaining all of their respective differences, available from exactly the same localities, we might consider proof of specific separation to be demonstrated. Unfortunately such individuals are not yet at hand. However, both forms are available from points about 50 miles apart in southeastern Arizona; and, in the Big Bend region of Texas, from localities separated by only 30 miles. The question arises whether the differences noted could be due to racial trends and the ecological variations between these localities. Fortunately there are other differences between *dulcis* and *humilis*, besides the presence or absence of supraoculars, and these can be employed to validate or reinforce decisions premised on this character.

First, let us consider dorsal scale counts: In the area known to be inhabited by both forms, no specimen of *humilis* has less than 254 dorsals (range 254–275), while no specimen of *dulcis* has more than 246 (range 236–246).

Secondly, we have the splitting of the anterior supralabials: Every specimen of *dulcis* from Fort Clark westward has a split anterior supralabial (i.e. it belongs to the subspecies *dissectus*); on the other hand, no available specimen of *humilis* has this character.

Third, there is a difference in size. Such specimens as are available which exceed 300 mm. are all *humilis;* it is evident that *dulcis* does not reach this size.

Now it would appear that if the supraoculars were merely a fluctuating character within a single species, gradually becoming rarer from east to west (for *dulcis* is more common in the eastern part of the joint range, and *humilis* in the west) certainly the other indicative characters would not all change simultaneously, so that we would find some specimens of *humilis* with low dorsal scale counts, and some with split anterior supralabials; and, correspondingly, specimens of *dulcis* would be found with the antithetical characters. No such specimens have come to light. I therefore conclude that *dulcis* and *humilis* are distinct species. No doubt some day this will be verified by finding both forms in the same canyon, somewhere in Arizona, New Mexico, or western Texas, with each species retaining all of its distinctive characters, thus making the decision unquestioned. But I likewise conclude that, rarely, *humilis* is found with supraoculars, as is the case with the two specimens from eastern San Diego County previously mentioned. These are not to be classified as *dulcis* merely because of the presence of these anomalous scales, since they are *humilis* rather than *dulcis* in four other characters: they are too large for *dulcis;* their dorsal scale counts are much too high (292 and 301); they have 12 scale rows around the tail, as is the case in all western *humilis,* while *dulcis* has 10; they are without the split anterior supralabials characteristic of all western *dulcis*. In all of these characters they are like *humilis* from the area where they are found, so it must be concluded that the supraoculars are aberrant. The specimen from Yuma, Arizona, mentioned by Van Denburgh and Slevin (1913, p. 409), may also have been an aberrant of this type; since the specimen was lost in the San Francisco fire this cannot be verified. Whether *dulcis* occasionally lacks supraoculars I cannot say.

Dulcis-myopicus-dissectus Relationship

Up to the present time *dulcis* (with a single anterior supralabial) and *myopicus* (with a divided anterior supralabial) have been considered separate species. I have found it advisable, as discussed elsewhere, to divide *myopicus* into two subspecies, by reviving Cope's *dissectus*. Furthermore in material newly available, I find evidence of intergradation both between *dulcis* and *myopicus,* and between *dulcis* and *dissectus;* and since *dulcis* is the oldest form, both of the others become *dulcis* subspecies. The geographical picture is quite consistent, the area of intergradation being rather narrow. *Dulcis* is found to have a much smaller range than *myopicus* and *dissectus,* which surround the former on all sides except the east. *Dulcis* is restricted to central Oklahoma, central and southern Texas, Nuevo León, and northern Tamaulipas. *Dissectus* and *myopicus* are found in southwestern Kansas, northern and western Oklahoma, western Texas, southern New Mexico, southeastern Arizona, Coahuila, western Nuevo León, southern Tamaulipas, and northern Veracruz. In spite of many published reports, I have been unable to locate a specimen of *dulcis dulcis* from Arizona, New Mexico, or trans-Pecos Texas. Such specimens of worm snakes with supraoculars as have come to light from these areas all have divided anterior supralabials, and should be referred to *dissectus*.

The area of intergradation between *dulcis dulcis* and *d. dissectus* may be indicated by the following intergrades:

U. Okla. 4522, 7 mi. SW of Hollis, Harmon County, Okla.
(Has a split anterior supralabial on the right, not on the left, thus being *dissectus* on the right, and *dulcis* on the left).

U. Okla. 13,106, Comanche County, Okla.
(The division between the parts of the anterior supralabials is anomalous on the right, in that it does not reach the nasal suture).

U. Okla. 13,111, Comanche County, Okla.
(The anterior supralabial is split angularly on one side only; it is entire, i.e. *dulcis* type, on the other).

The following *dulcis-myopicus* intergrade is at hand:

FMNH 30,615 Ojo de Agua, Cerro Potosí, Nuevo León.
(An incomplete suture in the ocular is in evidence on both sides. In other specimens from the same area this is complete, thus forming paired anterior supralabials).

Besides the intergrades from Comanche County mentioned above, typical specimens of both *dulcis* and *dissectus* are available from that county.

Thus far only one specimen of either *dulcis, dissectus,* or *myopicus* has been available (out of some 200 specimens) which does not fit into a logical geographic picture. This is a specimen of *dulcis* (U. Mich. 77,541) from Cimarron County, Oklahoma, from which it would be more logical to expect *dissectus.*

Other differences between *dulcis* and *myopicus* besides the supralabials are discussed under the latter form.

The third objective of the present investigation, namely, decisions respecting the validity of the species and subspecies which has been proposed, will be set forth under the discussions of the several forms, particularly in the paragraphs under taxonomic status and relationships.

DESCRIPTIONS OF SPECIES AND SUBSPECIES

Leptotyphlops dulcis dulcis (Baird and Girard)

TEXAS WORM SNAKE

1853. *Rena dulcis* Baird and Girard, Cat. N. Amer. Rept., Pt. 1, p. 142. Type locality: Between San Pedro and Comanche Springs, Texas. Type specimen: USNM 7296.
1861. *Stenostoma dulce* Cope, Proc. Acad. Nat. Sci. Phila., Vol. 13, p. 305.
1883. *Stenostoma rubellum* Garman, Mem. Mus. Comp. Zoöl., Vol 8, No. 3, p. 130. Type locality: Uvalde, Uvalde County, Texas. Type specimen: MCZ 4584.
1891. *Leptotyphlops dulcis* Stejneger, Proc. U. S. Nat. Mus., Vol. 14, p. 501.
1892. *Glauconia dulcis* Cope, Proc. U. S. Nat. Mus., Vol. 14, p. 590.

Distribution.—Central Oklahoma and the Panhandle, south through central Texas to northern Tamaulipas and central Nuevo León, Mexico.

Diagnosis.—A subspecies with supraoculars, and with single, or undivided, anterior supralabials. It has 10 scale rows around the tail. The 7 median dorsal scale rows are brown or light brown; the dorsal scale counts vary from 206 to 255. The presence of supraoculars will suffice to distinguish this form from all *humilis* subspecies, including *segregus;* and the undivided anterior supralabials from *dissectus, myopicus,* and *bressoni.* In small specimens a microscope will be required to determine whether these scales are, or are not, divided. The 10 scale rows around the tail will segregate *dulcis* from *maximus,* for the latter has 12.

Material.—I have had available for study about 135 specimens of this subspecies from Oklahoma, Texas, and northeastern Mexico.

Description.—The body is almost cylindrical from head to tail. The head is slightly distinct, being a trifle widened and flattened; the tail is somewhat reduced in diameter and terminates in a sharp spine. Viewed from the side the head slants forward and downward from the interoccipital. The snout is rounded; it extends considerably beyond the lower jaw, which is inset. Viewed from above the head is widest at the occipitals, whence it narrows forward to the nostrils and is then curved around the snout. There is a flattened area at the eye. The longest available specimen measured 271 mm. over-all; the smallest 75 mm. The ratio of the adult body length to the diameter averages 50. The ratio of the body length over-all to the tail length is 18.6.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals. There are 10 rows around the tail; the reduction from 14 to 12 is effected by combining rows 2 and 3 (above the mid-ventral) into a new second row. This takes place one to three scales ahead of the anal plate. The next condensation to 10 occurs at the base of the tail. The anal plate is somewhat pointed and is entire. The mid-dorsal scale count, from rostral to tail spine (but not counting either) averages 227.84 ∓ 0.96; extreme range 206 to 255; interquartile range 221 to 235; coefficient of variation 4.4 per cent. The subcaudals average 14.56 ∓ 0.83, the extreme range being 12 to 17; interquartile range 13.8 to 15.3; coefficient of variation 7.6 per cent.

The rostral is curved from the underside of the upper jaw over the snout, reaching back to a point even with the anterior edge of the eye and sometimes approaching its center. The rostral is wedge-shaped; the posterior end may be rounded or pointed. At the level of the nostril the rostral is slightly wider than either the nasal or ocular.

The supralabial series comprises (besides the rostral) four scales on each side: an inferior nasal, an anterior supralabial, an ocular, and a posterior supralabial. The nasal is divided into two parts, a superior and an inferior, by a suture through the nostril. The suture is directed upward as it nears the rostral. The superior nasal is larger than the lower part; it narrows as it approaches the prefrontal, which prevents a contact with its fellow on the other side. The inferior nasal narrows toward the lip. The anterior supralabial is higher than wide; it is pointed at the top, the point being on the posterior edge; it does not reach the level of the eye. The ocular is the largest head scale, excepting only the rostral. It narrows considerably toward the lip. The eye is either at the center of the ocular or slightly anterior thereto; it appears as a black spot beneath the skin, the surface of which is not raised by reason of the presence of the eye. The posterior supralabial is about as high as wide, triangular, but with the apex cut off. It occupies more lip space than any other scale except the rostral.

The supraoculars are small, slightly wider than high, and point forward and outward toward the upper tips of the oculars (fig. 4).

The parietals are large, more than three times as long as wide; they narrow laterally as they approach contact with the posterior supralabials. The occipitals are of about the same size as the parietals. A temporal is interposed between each occipital and the posterior supralabial on that side.

Of the mid-dorsal series the first four scales (prefrontal to interoccipital inclusive) are substantially equal in size, although the first and third are often slightly larger than the other two. Posteriorly, on the neck, the scales of the mid-dorsal series are somewhat widened transversely, as compared to the first four. Sometimes this widening is quite conspicuous.

The mental is wide and short. The infralabials number 4 on each side; the posterior is the largest. The chin-shields are much smaller than the ventral scales, into which they merge immediately behind the head.

The scales on the top and sides of the head, as far back as the parietals, are dotted with tiny pits; there are some pits on the occipitals.

The 7 median dorsal scale rows are medium to light brown (alcoholic colors); the lateral pair of this series are somewhat lighter than the central 5, for the change from the dorsal dark color to the ventral light is more gradual than in *humilis.* The color is applied by means of many tiny punctations. Often the scales appear to be darker on the edges; yet in other cases the edges are lighter, a condition possibly resulting from the imminence of exuviation. The color below is pink, tan, or cream; there is less contrast between dorsum and ventrum than in *humilis humilis.*

The head is brown above but the rostral, lips, and under-jaw are light.

Taxonomic Status and Relationships. Intraspecific Variation.—I have already discussed at some length, in the initial section of this paper, the relationships between the species *dulcis* and *humilis*, and the subspecies *dulcis dulcis, d. dissectus*, and *d. myopicus*, for these were the problems which initiated the investigation. It has been shown that *humilis* and *dulcis* are apparently overlapping species; and that *dulcis dulcis* is a subspecies inhabiting a relatively small area, completely surrounded on all sides, except the east, by the more widely ranging subspecies with divided anterior supralabials (*dissectus* and *myopicus*). Intergrades are available from Harmon and Comanche counties, Oklahoma, and southern Nuevo León, Mexico. One of a series of specimens from San Antonio, Texas, may be an intergrade; the anterior supralabial may be divided on one side, but it is difficult to see whether there is a crease or a true suture. The geographical arrangement of the specimens at hand presents a consistent pattern, except for a specimen of *dulcis* from the Oklahoma panhandle, where *dissectus* would be expected.

I have also mentioned the unexpectedly wide dispersion of characters (especially dorsal scale counts) which suggests the possibility that this subspecies may really be composite. However, this is supposition only; I have been unable to make any logical segregation of the specimens.

There remains one problem of interest with respect to the subspecies *d. dulcis* by itself: Is there a definite trend in scale counts between the snakes found in northern Tamaulipas and the southern tip of Texas, northward, through central Texas, to the northern limit of the subspecies in central Oklahoma? We find that there is such a trend. In the five southern counties of Jim Hogg, Starr, Hidalgo, Cameron, and Brooks, 16 specimens have a mean dorsal count of 236.50 ∓ 1.81; from the four central counties of Atascosa, Bexar, Bosque, and McLennan there are 57 specimens with a mean of 226.60 ∓ 1.33; while 11 specimens from Comanche County, Oklahoma, have a mean of 219.00 ∓ 2.84. By the *t*-test these differences are found to be significant, that between southern and central Texas being of the order of $P = 0.001$,[7] while between central Texas and Oklahoma, $P = 0.02$. Hence there is a definite decrease in the number of dorsal scale counts in this subspecies from its southern to its northern limit. The southern Texas specimens are somewhat more uniform than the other two groups, the strangely high dispersion, which I have mentioned before, not being evident in that area. The coefficients of variation from south to north are 2.25, 4.42, and 4.30 per cent.

A similar investigation of subcaudal scales indicates no significant trend, the means from south to north being, respectively, 14.39 ∓ 0.25, 14.58 ∓ 0.14, and 14.65 ∓ 0.24. These small differences are found to be without significance.

There seem to be no consistent color variations in *dulcis*. Throughout the range, the seven dorsal scale rows run from medium to light brown. Rarely a specimen is seen which is almost as dark as *h. humilis* from western San Diego County. Specimens from Cameron County are somewhat darker than those in the center of the state.

Garman's *rubellum* is to be considered a synonym of *dulcis dulcis*. As Stejneger has already pointed out (1891, p. 501), the various characters upon which Garman segregated *rubellum* were all premised, either on errors in the original description of *dulcis* by Baird and Girard, or on misinterpretations of that description by Garman. The type of *dulcis* is anomalous in having the occipital in contact with the posterior supralabial on the right side, but this has no bearing on the validity of *rubellum*. Aside from this there seem to be no important differences between the two types. The type locality of *rubellum*, Uvalde, Texas, is within the area inhabited by *dulcis*, and the dorsal scale count of the type, 239, kindly supplied me by Mr. B. Shreve of the Museum of Comparative Zoölogy, is within the normal range of *dulcis*.

Locality Records.—In the small, light colored snakes belonging to the subspecies *dulcis* (anterior supralabials entire), and *myopicus* or *dissectus* (anterior supralabials divided), it is often quite difficult to ascertain the condition of the critical scale; one would not notice the important suture unless he were especially looking for it. As a result there has been much confusion between the three subspecies, and, in western Texas, with *segregus* as well. For this reason I have deemed it inadvisable to include localities hitherto recorded in the literature, but have restricted the following list to localities represented by specimens which I have examined, together with the type locality of *rubellum*. While previous records from central Texas were no doubt correctly ascribed to *dulcis*, it is probable that those from western Texas, southern New Mexico, and southeastern Arizona were *dissectus*. *Dulcis*, however, may well be expected in northeastern New Mexico.

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[7] Meaning one chance in a thousand that the two samples were drawn from a single homogeneous population.

There have been reports of *dulcis* from Arkansas (Dellinger and Black, 1938, p. 18). I have been informed by Mr. B. C. Marshall, who was presumed to have captured, at Imboden, Arkansas, the specimens upon which this record was based, that they were merely forwarded from Imboden, but were originally obtained by him in Texas. This record, therefore, should be suppressed. So far as I know, there are at present no authentic Arkansas records of *Leptotyphlops*.

The verified *dulcis* records follow:

OKLAHOMA: *Cimarron County; Cleveland County*—Norman; *Kiowa County*—Gotebo; *Comanche County*—5 mi. n. of Cache; *Harmon County*—7 mi. sw. of Hollis (*dissectus* intergrade); *Choctaw County*.

TEXAS: *County uncertain*—Between San Pedro and Comanche Springs (type locality); *Lubbock County*—Lubbock; *Palo Pinto County*—3 mi. w. of Millsap, Palo Pinto; *Erath County; Bosque County*—Clifton, Valley Mills; *McLennan County*—Waco, Eddy, Bruceville, Tonk Creek, China Springs, Cameron Farm; *Tom Green County*—Christoval; *Burnet County*—3 mi. e. of Burnet; *Travis County*—Austin, Marshall Ranch; *Hayes County*—San Marcos; *Bexar County*—San Antonio (also 10 mi. n., 22 mi. n., 12 mi. sw.), Somerset (also 10 mi. s., 3 mi. sw., 7 mi. sw.), Helotes, Von Ormy; *Uvalde County*—Uvalde (type locality of *rubellum*); *Medina County*—Diversion Lake; *Atascosa County*—Lytle, Benton; *Victoria County*—Victoria; *Jim Hogg County*—E. of Hebronville; *Brooks County*—30 mi. sw. of Falfurrias; *Starr County*—3 mi. se. of Rio Grande City; *Hidalgo County*—Edinburg; *Cameron County*—Brownsville, Harlingen.

NUEVO LEON: Monterrey, Ojo de Agua (*myopicus* intergrade).

TAMAULIPAS: Matamoros, Bagdad.

Leptotyphlops dulcis dissectus (Cope)

NEW MEXICAN WORM SNAKE

1883. *Stenostoma dulce* Cope, Proc. Acad. Nat. Sci. Phila., Vol. 35, p. 11.
1892. *Glauconia dulcis* (part) Cope, Proc. U. S. Nat. Mus., Vol. 14, p. 590.
1896. *Leptotyphlops dulcis* Cockerell, Am. Nat., Vol. 30, p. 326.
1896. *Glauconia dissecta* Cope, Am. Nat., Vol. 30, p. 753. Type locality: Lake Valley, Sierra County, New Mexico. Type specimen: ANSP 10,752.
1933. *Leptotyphlops myopica* (part) Stejneger and Barbour, Check List N. Amer. Amph. Rept., Ed. 3, p. 85.

Distribution.—From southern Coahuila, Mexico, north and northwest through trans-Pecos Texas and southern New Mexico to southeastern Arizona;

also southern Kansas, and central and northeastern Oklahoma.

Diagnosis.—A subspecies with supraoculars, differing from *dulcis* and *maximus* in having the anterior supralabial vertically divided into two parts (fig. 5). From *bressoni* it differs in having the parietals in contact with the posterior supralabials. From *myopicus* it differs in usually having in excess of 224 dorsals; also one or both occipitals are often divided, and the fifth dorsal is conspicuously wider than the fourth, which characteristics are seldom present in *myopicus*. It has 10 scale rows around the tail, and the dorsals vary from 224 to 246. The seven mid-dorsal scale rows are colored from light to medium brown.

Material.—I have had available for study 14 specimens from Oklahoma, 5 from Kansas, 3 from Texas, 7 from New Mexico, 4 from Arizona, and 2 from Coahuila, a total of 35.

Description.—The body is almost cylindrical from head to tail. The head is slightly distinct, being a trifle widened and depressed; the tail is somewhat reduced in diameter and terminates in a sharp spine. Viewed from the side the head slants forward and downward from the interoccipital. The snout is rounded; it extends considerably beyond the lower jaw, which is inset. From above, the head appears widest at the occipitals, whence it narrows forward to the eyes and is then curved about the snout. There is a flattened area at the eye. The longest available specimen measures 272 mm. over-all; the smallest 90 mm. The subspecies seems to reach its largest size in southern New Mexico; it is definitely smaller in Kansas and Oklahoma. The ratio of the adult body length to the diameter averages 51. The ratio of the body length over-all to the tail length is about 21.7.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals, except on the neck. There are 10 rows around the tail; the first reduction from 14 to 12 is effected by combining rows 2 and 3 (above the mid-ventral) into a new second row. This takes place two or three scales ahead of the anal plate. The final reduction to 10 occurs at the base of the tail. The anal is somewhat pointed and is entire. The mid-dorsal scale count, from rostral to tail spine (but not counting either), averages 238.1 ∓ 0.72; extreme range 224 to 246; interquartile range 235.4 to 240.9; coefficient of variation 1.7 per cent. The subcaudals average 13.90 ∓ 0.18, the extreme range being 12 to 16; interquartile range 13.2 to 14.6; coefficient of variation 5.5 per cent. These figures omit consideration of *dissectus-dulcis* intergrades.

The rostral is curved from the underside of the upper jaw over the snout, reaching back about to the anterior edge of the eye, and sometimes even approaching the center. The rostral is wedge-shaped; the posterior end is rounded. At the level of the nostril the rostral is slightly wider than either the nasal or ocular.

The supralabial series comprises (besides the rostral) 5 scales on each side: an inferior nasal, an anterior supralabial, divided into two scales by a vertical suture (fig. 5), an ocular, and a posterior supralabial. The nasal is divided into two parts, a superior and an inferior, by a slanting suture through the nostril. The suture is directed upward as it approaches the rostral. The superior nasal is larger than the lower part, narrowing as it approaches the prefrontal, which prevents a contact with the opposite nasal. The inferior nasal narrows as it approaches the lip. Of the two parts of the anterior supralabial, the posterior is both wider and higher; both parts are higher than wide, and are pointed at the top. The posterior reaches the bottom of the eye but not the center. The ocular is the largest head scale, excepting only the rostral. It narrows considerably as it approaches the lip, for the rear section of the anterior labial is largely cut out of the ocular. The eye is either at the center of the upper half of the ocular or slightly anterior thereto; it appears as a black spot beneath the skin, the surface of which is not raised by reason of its presence. The posterior supralabial is about as high as wide, triangular, but with the apex truncated. It occupies more lip space than any other scale except the rostral.

The supraoculars are small, slightly wider than high, and point forward and outward toward the upper tips of the oculars. The parietals are large, about three times as long as wide; they narrow laterally as they approach contact with the posterior supralabials. The occipitals, when entire, are of about the same size. However, it is characteristic of this subspecies that the occipitals are often divided by a diagonal suture; in effect, the second dorsal row on either side of the mid-dorsal is carried forward one additional scale, thus terminating at the parietals (fig. 7) instead of at the occipitals, as in other subspecies. Often this is the case on one side only. The postoccipitals are often enlarged. When the occipital is divided, the upper part is larger than the lower, and may be considered the true occipital. Thus it is separated from the posterior supralabial by two, rather than the customary single, scale.

Of the mid-dorsal series the first four scales (prefrontal to interoccipital inclusive) are sometimes equal in size, although more often the third, or third and fourth are slightly larger than the other two. But the fifth scale is very much wider than the prior four, sometimes more than twice as wide. This is a character in which *dissectus* differs from *myopicus*. Posteriorly, after the fifth scale, the mid-dorsal series, in the course of a few scales, again narrows to normal.

The mental is wide and short. The infralabials number 4 on each side; the posterior is the largest. The chin-shields are much smaller than the ventrals, into which they merge immediately behind the head.

The scales of the top and sides of the head, as far back as the parietals and interparietal, are dotted with tiny pits; there are occasionally pits on the occipitals also.

The 7 median dorsal scale rows are medium to light brown (alcoholic colors); the lateral pair of this series are somewhat lighter than the central 5. The color is applied by means of many tiny punctations. Often the scales appear to be darker on the edges; yet in other cases the edges are lighter, a condition possibly resulting from the approach of shedding time. The color below is pink, tan, or cream; there is usually less sharp contrast between dorsum and ventrum than in *humilis humilis*.

The head is brown above, but the rostral, lips, and under-jaw are light.

Taxonomic Status and Relationships. Intraspecific Variations.—The general relationship between *dulcis* on the one hand, and *dissectus* and *myopicus* on the other, has already been discussed as one of the problems which this study was undertaken to determine. In its scale arrangements *dulcis* seems to be the simpler of the two and is probably the more primitive. Nevertheless *myopicus* and *dissectus* completely surround *dulcis* except on the east.

I hesitated for a considerable time before splitting *myopicus* and re-establishing *dissectus;* however, with the exception of very few specimens a consistent geographical segregation can be made on the basis of dorsal scale counts alone. When to this are added the sharp increase in size of the fifth dorsal as compared to the fourth—a character peculiar to the northern specimens (*dissectus*)—and the frequent division of the occipitals, also a peculiarity of the United States individuals, the division appears to be justified.

Discussing first the geographical situation with respect to dorsal scale counts, we note the following: If we were to make an arbitrary distinction between *myopicus* and *dissectus* at 224, we find that one specimen out of eleven in the *myopicus* area would be misplaced, this being U. Mich. 69,408 from Tanoyuca (Tantoyuca?), Veracruz, for this specimen has 236 dorsals; the other ten have 222 or less, the average being 210, range 199 to 222.

Of the specimens within the *dissectus* territory there is only one specimen, out of 35, with less than 230 dorsals; this is a specimen from Norman, Oklahoma, with 224 dorsals. This individual has peculiar head scales, as the parietal is divided on the left and other scales are abnormal in shape. In addition there are three *dulcis-dissectus* intergrades all of which have less than 224 dorsals; this might well be expected, as *dulcis,* in the area of intergradation, usually has less than 220 dorsals.

A second difference observable between *dissectus* and *myopicus* is the sharp increase in width from the fourth to the fifth dorsal usually evident in *dissectus,* the fifth being as much as twice as wide as the fourth. This widening is seldom in evidence in *myopicus,* for, in these, the two scales are likely to be the same size, thus resembling *dulcis* in Texas, or the fifth may be slightly larger. The postoccipitals are somewhat more enlarged in the northern specimens than the southern.

Another fairly consistent difference between the southern and northern specimens is in the occipitals themselves. In *dissectus* these are often divided at an angle, so that two scales, rather than the usual single scale, separate the occipitals from the posterior supralabials. The trend in this character is shown by the following table:

	NUMBER OF DIVIDED OCCIPITALS PER SPECIMEN		
	0	*1*	*2*
Myopicus	8	0	0
Dissectus			
West Texas	1	2	0
New Mexico	2	1	3
Arizona	1	3	0
Oklahoma	6	3	2
Kansas	2	3	0
	—	—	—
	20	12	5

It will be observed that no specimen of *myopicus* has a split occipital, while of *dissectus* 59 per cent have one split at least. The difference between the two is significant. If we consider a specimen having at least one split occipital, as being separated from those having none, we have the following contingency table:

	Without Divided Occipitals	With One or More Divided Occipitals
Myopicus	8	0
Dissectus	12	17
Total	20	17

By the chi-square test we find that there is only one chance in a hundred that these samples could have been drawn from the same population. However, a key based on this character would properly segregate only two thirds of the specimens.

Split occipitals are rare among Texas and Oklahoma *dulcis dulcis*, there being only one specimen out of 53 with this character, and this one has it on one side only. Thus we have, in this, another average difference between *dissectus* and *dulcis*. With reference to the relationship between these two, it has already been mentioned that there are three apparent intergrades available from Oklahoma, one of which is a perfect *dissectus* on the right side of the head, and *dulcis* on the left. Intergradation (or possibly hybridization) is more definitely indicated in Oklahoma between *dissectus* and *dulcis* than between *myopicus* and *dulcis* in Mexico, where, if all the localities are accurate, which is not always the case with specimens collected in the days of the Boundary and Railroad Surveys, there may be an overlapping of *myopicus* and *dulcis* rather than a merging, as in the north between *dissectus* and *dulcis*.

The reason I have mentioned hybridization, as being a possibility in the place of intergradation in Oklahoma, is the seemingly wide separation of the two pure populations and the variations amongst the intergrades. In this area most *dulcis* run close to 215 in dorsal scale counts; *dissectus* about 235. *Dissectus* often has one or both occipitals split, *dulcis* has not. *Dissectus* has a widened fifth dorsal; this is seldom present in *dulcis*. All of these characters fluctuate in the intergrades. For example, the *dulcis-dissectus* intergrades have lower dorsal scale counts than any other *dissectus*, but they are not higher than any pure *dulcis*, for one of the latter is as high as any *dissectus*. This sudden and simultaneous change in three characters would not be expected in a territory characterized by gradual, rather than sudden, changes in ecological conditions. This suggests a separation, followed by a re-merging. This situation might also explain the high coefficient of variation in *dulcis*, to which I have made reference before.

The largest specimens of *dissectus* occur in New Mexico, where the dorsal counts are highest. Specimens from Kansas and Oklahoma are definitely smaller. At present, between these areas, there is a territorial gap—northeastern New Mexico and the panhandle of Texas—from which no specimens are available.

Locality Records.—Because of the confusion which has existed between *dulcis* and *dissectus* (or *myopicus*), I list below only the localities from which specimens have been examined in the course of this study, or such as may be represented by specimens in which the bifurcated anterior supralabial has been especially checked by others.

OKLAHOMA: *Tulsa County*—Tulsa; *Canadian County*—7 mi. n. of Yukon; *Cleveland County*—Norman; *Comanche County; Harmon County*—7 mi. sw. of Hollis (*dulcis* intergrade); *Payne County*—Stillwater.

KANSAS: *Barber County*—2 mi. w. of Lake City; *Clark County*—Stevenson Ranch; *Meade County*—1 mi. w. of State Lake.

NEW MEXICO: *Eddy County*—East boundary Carlsbad Cavern National Park; *Dona Ana County*—Mesilla Valley, Mesilla Park, Las Cruces; *Sierra County*—Lake Valley (type locality).

ARIZONA: *Cochise County*—Mouth of Ramsey Canyon (Huachuca Mountains), Naco, 4 mi. sw. of Portal.

TEXAS: *Reeves County*—Near Pecos, Balmorhea; *Brewster County*—Oak Creek (Chisos Mountains).

COAHUILA: San Pedro, 4 mi. w. of Saltillo.

Leptotyphlops dulcis myopicus (Garman)

TAMPICO WORM SNAKE

1883. *Stenostoma dulce* (part) Yarrow, Bull. U. S. Nat. Mus., No. 24, p. 142.
1883. *Stenostoma myopicum* Garman, Mem. Mus. Comp. Zoöl., Vol. 8, No. 3, p. 6. Type locality: Savineto near Tampico, Tamaulipas, Mexico. Cotype specimens (3): MCZ 4526.
1893. *Glauconia myopica* Boulenger, Cat. Snakes of British Museum, Vol. 1, p. 69.
1900. *Glauconia dulcis* (part), Report U. S. Nat. Mus. for 1898, p. 717.
1929. *Leptotyphlops myopica* Barbour and Loveridge, Bull. Mus. Comp. Zoöl., Vol. 69, No. 10, p. 345.

Distribution.—From northern Veracruz and southern San Luis Potosí northward across southern Tamaulipas to central Nuevo León, Mexico. This subspecies, as here defined, does not occur in the United States.

Diagnosis.—A subspecies with supraoculars, differing from *dulcis* and *maximus* in having the anterior supralabial vertically divided into two parts. The parietals are in contact with the posterior supralabials, which is not the case with *bressoni*. From *dissectus* it differs in usually having less than 224 dorsals, while the former has more. Other differences of *myopicus* from *dissectus* are the frequent division of the occipitals in the latter, but not the former; also, *dissectus* usually has a much larger fifth dorsal than the fourth, which is not the case with *myopicus*. The seven mid-dorsal rows are colored from medium to dark brown. There are 10 scale rows around the tail.

Material.—I have had available for study 7 specimens of this subspecies and have had the scale counts on 4 others, including the three cotypes.

Description.—The body is almost cylindrical from head to tail. The head is slightly distinct, being a trifle widened and vertically compressed; the tail is somewhat reduced in diameter and terminates in a sharp spine. Viewed from the side, the head slants forward and downward from the interoccipital. The snout is rounded; it extends considerably beyond the lower jaw, which is inset. The head is widest at the posterior supralabials; it narrows forward to the nostrils and is then curved about the snout. There is a flattened area at the eye. The longest available specimen measures 227 mm. over-all; the smallest 89 mm. The ratio of the adult body length to the diameter averages 54. The ratio of the body length over-all to the tail length is about 18.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals, except that in the Coahuila specimens the mid-dorsals are widened at the neck. There are 10 scale rows around the tail. The anal is somewhat pointed and is entire. The mid-dorsal scale count, from rostral to tail spine (but not counting either), averages 212.9; the several counts are 199, 205, 206(2), 211, 212, 213, 215, 217, 222, 236. The subcaudals average 14.1; the extreme range being 11 to 17.

The rostral is curved from the underside of the upper jaw over the snout, reaching back to a point about even with the anterior edge of the eye. The rostral is wedge-shaped; the posterior end may be rounded or pointed. At the level of the nostril the rostral is slightly wider than either the nasal or ocular.

The supralabial series comprises (besides the rostral), 5 scales on each side: an inferior nasal, an anterior supralabial, divided by a vertical suture into two parts, an ocular, and a posterior supralabial. The nasal is divided into two sections, a superior and an inferior, by a suture through the nostril. The suture is directed upward as it approaches the rostral. The superior nasal is larger than the lower part; it narrows as it approaches the prefrontal, which prevents contact with its fellow on the other side. The inferior nasal narrows toward the lip. The two parts of the anterior supralabial are quite unequal in size, the rearward section being both wider and higher; however, it does not quite reach the level of the eye. It is pointed at the top. The ocular is the largest head scale, excepting only the rostral. It narrows considerably as it approaches the lip, for the rear part of the anterior supralabial cuts deeply into it. The eye is either at the center of the ocular or slightly anterior thereto; it appears as a black spot beneath the skin. The posterior supralabial is about as high as wide, triangular, but with the apex cut off by contact with the parietal. It occupies more lip space than any other scale except the rostral.

The supraoculars are small, slightly wider than high, and point forward and outward toward the nasal-ocular sutures. The parietals are large, about three times as long as wide; they narrow slightly as they approach contact with the posterior supralabials. (One specimen lacks this contact on one side only). The occipitals are of about the same size; they are not divided, thus differing from *dissectus,* which often has a division in these scales. A temporal is interposed between each occipital and the posterior supralabial on that side.

Of the mid-dorsal series the first four scales (prefrontal to interoccipital inclusive) are substantially equal in size, although the last two are sometimes slightly larger than the others. Posteriorly, on the neck, the scales of the mid-dorsal series are slightly widened transversely, as compared to the first four;

this widening is quite conspicuous in the specimens from Coahuila.

The mental is wide and short. The infralabials number 4 on each side; the posterior is the longest. The chin-shields are much smaller than the ventrals into which they merge immediately behind the head.

The scales of the top and sides of the head, as far back as the parietals, are dotted with tiny pits; there are some pits on the occipitals.

The 7 median dorsal scale rows are medium brown (alcoholic colors), except those from Coahuila which are very dark brown.

The head is brown above. Some specimens show considerable brown on the lower labials, the ventrum at the neck, and the anal.

Taxonomic Status and Relationships. Intraspecific Varaitions.—The relationship between *myopicus* and *dissectus* has been discussed under the latter subspecies. Intergrades are to be expected along the border between Coahuila and Nuevo León.

The relationship between *myopicus* and *dulcis* is more uncertain; these forms may intergrade, or may overlap; the few specimens now available from Nuevo León are not sufficient to permit a definite decision. On the one hand there is one specimen, FMNH 30,615, from Ojo de Agua, Cerro Potosí, Nuevo León, which seems to be a *myopicus-dulcis* intergrade in that the suture, which normally (in *myopicus*) separates the back half of the anterior supralabial from the ocular, is incomplete. Three other specimens from the same locality are normal *myopicus*. This incomplete suture is the same character by which Brongersma separated *ihlei* from the South American form *macrolepis*.

The National Museum has specimens of both *dulcis* and *myopicus* from near Monterrey, each typical. If these two localities are to be considered accurate, then these two forms would seem to overlap; however, they were collected in the old days when the localities catalogued were sometimes the localities from which the specimens were forwarded, rather than those of actual collection. Thus the question of this relationship is still in a doubtful status.

The scale counts of the *myopicus* specimens available are geographically consistent, with a dorsal-scale count range of 199 to 222, with the exception of the most southerly specimen, U. Mich. 69,408 from Tanoyuca (Tantoyuca?), Veracruz, which has 236 dorsals. One of the cotypes with 199 dorsals is notable in having the lowest count of any specimen of the genus which has yet come to light from North or South America.

Myopicus may be related to *bressoni* and, through the latter, to *macrolepis* of South America.

Not enough specimens of *myopicus* are available to make certain of any geographical trends. The most distinctive specimens I have seen are a series of four from Ojo de Agua, Cerro Potosí, Nuevo León, (FMNH 30,615–8). These are dorsally much darker than the specimens from further south; also, they have some spotting on the chin-shields and anal.

It is probable that, as additional material becomes available, variations in dorsal scale counts and color will be found to follow ecological changes, as is the case with *humilis* in southern California.

It is interesting to observe that, while *dulcis* has a trend toward lower dorsal scale counts from south to north, *dissectus* and *myopicus*, as a group, have a reversed trend, the southern specimens having lower, and the northern higher counts.

Locality Records.—*Myopicus* has been reported at the following points in Mexico: NUEVO LEON: Ojo de Agua (Cerro Potosí), Monterrey; TAMAULIPAS: Savineto near Tampico (type locality); SAN LUIS POTOSI; VERACRUZ: Panuco, near Tanoyuca.

Leptotyphlops maximus Loveridge

GUERRERO WORM SNAKE

1932. *Leptotyphlops maximus* Loveridge, Proc. Biol. Soc. Wash., Vol. 45, p. 151. Type locality: Chilpancingo (alt. 4000–6000 feet), Guerrero, Mexico. Type specimen: MCZ 33,604.

Distribution.—Guerrero and Morelos, Mexico.

Diagnosis.—A species with supraoculars, and with a single anterior supralabial. It differs from other known species or subspecies in the United States or Mexico with supraoculars present, in having 12 rows of scales around the tail, whereas all others have 10.

Material.—I have had available for study four specimens of this species from Guerrero and Morelos, and data on the type and three paratypes kindly supplied by Mr. Benjamin Shreve.

Description.—The body is substantially cylindrical from head to tail. The head is slightly distinct, being a trifle widened and vertically compressed; the tail is somewhat reduced in diameter and terminates in a sharp spine. The snout is rounded; it extends considerably beyond the lower jaw, which is inset. From above the head appears widest at the occipitals, whence it narrows forward to the nostrils and is then curved about the snout. There is a flattened area at the eye. The longest available specimen measures 300 mm. over-all; the smallest individual measures 126 mm. The ratio of the adult body length to the diameter averages 45. The ratio of the body length over-all to the tail length is about 19.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals. There are 12 rows around the tail, the reduction from 14 occurring at the base of the tail. The anal is rounded and is entire. The mid-dorsal scale count, from rostral to tail spine (but not counting either), averages 223.6; extreme range 216 to 235; the counts on the available specimens are 216, 219, 220, 221 (2), 223, 234, 235. The subcaudals average 14.3, the extreme range being 13 to 16.

The rostral is curved from the underside of the upper jaw over the snout, reaching back to a point even with the anterior edge of the eye. The rostral is wedge-shaped; the posterior end is rounded. At the level of the nostril the rostral is slightly wider than either the nasal or ocular.

The supralabial series comprises (besides the rostral) 4 scales on each side; an inferior nasal, an anterior supralabial, an ocular, and a posterior supralabial. The nasal is divided into two parts, a superior and an inferior, by a suture through the nostril. The suture is directed upward toward the rostral. The superior nasal is larger than the lower part; it narrows as it approaches the prefrontal, which prevents a contact with its fellow on the other side. However, in FMNH 1263 from Balsas, Guerrero, the nasals contact on the mid-dorsal line.[8] The inferior nasal narrows as it approaches the lip; it is widest at the top. The anterior supralabial is higher than wide; it is pointed at the top, the point being on the posterior edge; it does not reach the level of the eye. The ocular is the largest head scale, excepting only the rostral. It narrows considerably as it approaches the lip. The eye is slightly anterior to the center of the ocular; it appears as a black spot beneath the skin, the surface of which is not raised by reason of the presence of the eye. The posterior supralabial is about as high as wide, triangular, but with the apex cut off where it engages the parietal. It occupies more lip space than any other scale except the rostral.

The supraoculars are small, wider than high, and point forward and outward toward the suture between the nasals and the oculars. The parietals are large, more than twice as long as wide; they narrow laterally as they approach contact with the posterior supralabials. The occipitals are of about the same size; they also narrow laterally. A temporal is interposed between each occipital and the posterior supralabial on that side. The postoccipitals, which are the terminal scales of the first lateral row on either side of the mid-dorsal, are somewhat enlarged.

Of the mid-dorsal series the first four scales (prefrontal to interoccipital inclusive) are substantially equal in size in some specimens; in others the posterior pair are widened. Where the interoccipitals are no wider than the frontal, the fifth scale is usually widened conspicuously; the subsequent scales are gradually reduced to a normal width.

The mental is wide and short. The infralabials number 4 on each side; the posterior is the largest. The chin-shields are much smaller than the ventrals, into which they merge behind the head.

The scales of the top and sides of the head, as far back as the parietals, are dotted with tiny pits.

The 7 median dorsal scale rows are from dark brown to orange (alcoholic colors). The color below is tan, or cream; the lateral line between the dark dorsal color and the light ventrum is very sharp and distinct.

The head is brown above, but the rostral, lips, and under-jaw are light, although there may be some dark spots on the chin. In the dark specimens the anal is punctated with dark brown. In some specimens the snout and tail tip are both light, but not with the conspicuous contrast of most members of the *albifrons* group.

The considerable variation in both scale configurations and color evident in the few specimens at hand indicates that this species may be divisible into two or more subspecies when adequate material becomes available.

Taxonomic Status and Relationships.—This species is probably related to *dulcis* and *myopicus*. In having somewhat longer supraoculars than these, and, occasionally a light spot on the tail, it shows some tendency toward *phenops* of the *albifrons* group.

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[8] If additional specimens from northwestern Guerrero show consistency in this character, subspecific differentiation will be warranted.

Locality Records.—Guerrero: Chilpancingo (type locality), Balsas; Morelos: Puente de Ixtla, near Huijintlan (10 miles south of Puente de Ixtla).

Leptotyphlops bressoni Taylor

MICHOACAN WORM SNAKE

1939. *Leptotyphlops bressoni* Taylor, Copeia, No. 1 of 1939, p. 5. Type locality: Hda. El Sabino, Uruapan, Michoacán, Mexico. Type specimen: EHT-HMS 5247.

Distribution.—At present this species is known only from the type specimen, with the locality given above.

Diagnosis.—A species readily distinguished from others in the *dulcis* and *humilis* groups, excepting *myopicus* and *dissectus,* by the vertical division in the anterior supralabial. From these latter it may be segregated by the presence of a small scale (the postocular) which separates each parietal from the adjacent posterior supralabial (fig. 6). These scales make contact in *myopicus* and *dissectus.*

Description of the Type Specimen.—Length over-all 265 mm.; length of tail 13 mm.; ratio of total length to tail length 20.4. Diameter of body 4.8 mm.; ratio of body length to diameter 55.

The body is sub-cylindrical, the neck being flattened and the posterior part of the body somewhat reduced in thickness. The tail is reduced in diameter and terminates in a spine.

The head is moderately depressed and flattened, with a prominent, rounded, overhanging snout. The rostral is curved from the underside of the upper jaw over the snout, reaching back as far as the front of the eye. Viewed from the front it is rather narrow, although wider than the nasals or ocular. The posterior tip is rounded. The supralabial series comprises five scales on each side, an inferior nasal, a double or split anterior supralabial, an ocular, and a posterior supralabial. The nasals are divided and are somewhat wider than the widest part of the oculars. The inferior nasal is smaller than the upper; the nasal suture rises upward toward the rostral. The superior nasals are prevented from meeting on the mid-dorsal line by the contact between the rostral and prefrontal. The anterior supralabial is large and is divided into two parts by a vertical suture. The posterior section is both wider and higher than the front part; it rises to a point at the level of the lower edge of the eye.

The posterior part of this supralabial cuts deeply into the ocular. The eye is somewhat forward of the center of the ocular. The posterior supralabial is triangular and is as wide as high. The supraoculars are small, about as wide but not as high as the frontal. They are prevented from meeting by the prefrontal-frontal contact, and are directed forward and outward on either side of the prefrontal. Of the mid-dorsal series the interparietal is the largest, followed by the interoccipital; both are larger than either the prefrontal or frontal. The parietals are twice as high as wide; contact with the posterior supralabials is prevented by the interposition of the first scales of the third lateral scale rows, which may be referred to as postoculars. The presence of these postoculars is the outstanding character of the species. The occipitals are large; they are prevented from contacting the posterior supralabials by the postocular on each side. The mental is wide but very short; it is slightly indented. There are four infralabials on each side, the posterior being enlarged and hidden by the overhanging upper jaw. The chin-shields are small and regular, and enlarge posteriorly as they merge into the ventral series.

The body is covered with 14 rows of smooth and imbricate scales of uniform size, neither the mid-dorsal nor mid-ventral being conspicuously enlarged. There are 10 rows around the tail, two rows being dropped 5 scales anterior to the anal plate, and two at the base of the tail. The first reduction is effected by combining the second and third rows above the mid-ventral row, which are combined into a new second row. The anal is entire. The median dorsal series from prefrontal to tail spine numbers 240, the subcaudals 16.

The 7 dorsal scale rows (in alcohol) are dark purplish brown, in solid color without lines, punctations, or light borders. There is some lightening of the last pigmented row on each side. The ventral color is fawn, with each scale lightly pigmented in its center; especially is this evident posteriorly. The lip edges, particularly the mental, are light. The anal has a central brown spot, and the subcaudals are centrally punctated. The rostral and the nasals are dotted with tiny pores.

Taxonomic Status and Relationships.—Since *bressoni* is known from but one specimen, we can only guess at its relationships. The presence of the postocular readily distinguishes it from all other known American *Leptotyphlops;* if this proves to be a consistent character in later specimens, its validity will be undoubted. The split anterior supralabial suggests an affinity to *myopicus,* to which it has other resemblances. It likewise seems allied to *L. macrolepis* Peters, 1857, a Venezuelan form, also characterized by a split anterior supralabial. *Macrolepis* has larger supraoculars and is darker than *bressoni*; also it lacks postoculars. But although less heavily pigmented, *bressoni* is reminiscent of *macrolepis* in having the centers of the ventral and subcaudal scales punctated, a conspicuous character in *macrolepis. Bressoni* may some day prove to be a link between *myopicus* and *macrolepis,* thus connecting the non-*albifrons* worm snakes of North and South America.

Leptotyphlops humilis humilis (Baird and Girard)

WESTERN WORM SNAKE

(Plate 6)

1853. *Rena humilis* Baird and Girard, Cat. N. Amer. Rept., Pt. 1, p. 143. Type locality: Valliecitas, California. Type specimen: USNM 2101.

1861. *Stenostoma humile* Cope, Proc. Acad. Nat. Sci. Phila., Vol. 13, p. 305.

1893. *Glauconia humilis* Boulenger, Cat. Snakes of British Museum, Vol. 1, p. 70.

1897. *Siagonodon humilis* Van Denburgh, Occ. Papers, Calif. Acad. Sci., 5, p. 150.

1907. *Leptotyphlops humilis* Ruthven, Bull. Am. Mus. Nat. Hist., Vol. 23, p. 573.
1931. *Leptotyphlops humilis humilis* Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 23, p. 340.

Distribution.—The coastal and cismontane area of southern California, and northern and central Lower California, from Santa Barbara to San Ignacio. Also the Mojave Desert and eastward of the Sierras, from the Death Valley region, through the southern tip of Nevada, to central and southeastern Arizona; also Cedros Island.

Diagnosis.—Humilis humilis is a subspecies characterized by a medium dorsal scale count (centering, in its most typical area, at 265 to 280, average 272), and the dark brown pigmentation of 7 or 9 mid-dorsal scale rows. From *dulcis, dissectus, myopicus, maximus,* and *bressoni* it may be distinguished by its lack of supraoculars; although rarely an aberrant specimen, far from *dulcis* territory, has been found with supraoculars. From *segregus* and *tenuiculus, humilis humilis* may be distinguished by the presence of 12 scale rows around the tail, whereas the others have 10. It is separated from the other *humilis* subspecies by differences in dorsal scale counts, and the extent and darkness of color on the median dorsal scale rows—except in the case of *utahensis,* which is characterized by a split fourth dorsal scale or a widened fifth.

Material.—The description of the subspecies *humilis humilis* which follows is founded on specimens from western San Diego County, of which about 60 have been available. These have been considered the basic specimens, since, from what is known about the type, it probably came from this locality. Specimens to the number of 82 (including *cahuilae* intergrades) are at hand from other areas. These are discussed under relationships and intraspecific trends.

Description.—The body is almost cylindrical from head to tail. The head is slightly distinct; the tail is somewhat reduced in diameter and terminates in a sharp spine. In side view the head is moderately depressed and slants downward and forward from the interoccipital. The snout is rounded and extends considerably beyond the lower jaw, which is inset. Viewed from above the head is widest at the occipitals, whence it narrows forward to the nostrils and is then rounded about the snout; a slight indentation is often evident just anterior to the eye. The longest available specimen measured 315 mm. over-all. Specimens exceeding 300 mm. probably represent about 7 per cent of the population. The smallest individual measures 103 mm. The ratio of the body length to the diameter averages about 55; half the specimens will fall between 50 and 60. The ratio of the body length over-all to the tail length is about 21; half the specimens will fall between 19½ and 22½.

The body is covered with 14 rows of smooth and imbricate scales of approximately uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals. There are 12 rows around the tail, the reduction from 14 being effected at the base of the tail. The anal is entire. The mid-dorsal scale count, from rostral to tail spine (but not counting either) averages 271.98∓0.83; extreme range 257 to 283; interquartile range 267.8 to 276.2;

coefficient of variation 2.3 per cent. The subcaudals average 17.86∓0.20; extreme range 15 to 21; interquartile range 16.9 to 18.8; coefficient of variation 7.9 per cent.

The rostral is curved from the underside of the upper jaw over the snout, reaching back sometimes to a point even with the anterior of the eye, often not this far. It never reaches the center of the eye. The rostral is wedge-shaped, but the posterior tip is rounded. At the level of the nostril the rostral is wider than either the nasal or ocular.

The supralabial series comprises (besides the rostral) 4 scales on each side: an inferior nasal, an anterior supralabial, an ocular, and a posterior supralabial.

The nasal is divided into two parts, a superior and an inferior, by a suture through the nostril. The suture is directed upward as it approaches the rostral. The superior nasal is larger than the lower part; it narrows as it approaches the prefrontal, which scale prevents a contact with the other nasal on the opposite side. The inferior nasal narrows toward the lip; it is widest below the nostril. The anterior supralabial is higher than wide; it has the appearance of having been cut out of the nasal, as the posterior edge of the superior nasal is a continuation of the same edge of the anterior supralabial. The posterior edge of the anterior supralabial is longer than the other edge. The ocular is the largest head scale, with the exception of the rostral. It narrows somewhat toward the lip. The eye is centered in the ocular; it appears as a black spot beneath the skin, the surface of which is not raised because of the presence of the eye. Around the black spot is a light ring. The posterior supralabial is about as high as wide, triangular, but with the apex cut off. It occupies more lip space than any other scale except the rostral.

The parietals are large, more than twice as long as wide; they contact the posterior supralabials. The occipitals are of about the same size, except that they are somewhat narrowed laterally. A small temporal, the beginning of a body scale-row, is interposed between each occipital and the posterior supralabial on that side.

Of the mid-dorsal series there is usually an increase in size from the prefrontal, through the frontal, to the interparietal. The interoccipital is usually slightly smaller than the interparietal, and is about the same size as the succeeding mid-dorsal row. Occasionally the scales of this row are somewhat widened for 6 to 8 scales behind the interoccipital.

The mental is small, triangular, and indented to form an avenue for the tongue. The infralabials are difficult to see, since they are hidden by the overhanging upper jaw; there are 4 on each side. The chin-shields are much smaller than the ventrals, into which they merge immediately behind the head.

The scales of the top and sides of the head are dotted with tiny pits.

The 7 median dorsal scale rows are medium to dark brown (alcoholic colors). Occasionally this color extends to an additional row on either side; when this is the case the last row is irregularly pigmented, often single scales along these rows being quite clear. Close examination shows the color to be applied by means of many tiny punctations, very close together. Often the scales appear to be darker on the edges; this seems to depend somewhat on the condition of the skin with respect to shedding and is probably due to the overlapping of the scales.

The head is brown above but the lips are usually light; the under-jaw is always light. There are often light scales in the temporal series. Frequently toward the tail there are light scales in the third row below the mid-dorsal on each side. Below the dorsal brown, the sides and belly are cream or light buff. Occasionally the anal is faintly spotted with brown.

Taxonomic Status and Relationships. Intrasubspecific Variation.—Humilis humilis was described from a specimen of somewhat uncertain locality, as was discussed at length in a previous paper.[9] The type specimen is now broken, and as the dorsal counts were not given in the original description they can never be ascertained. Because of its dark color we assume that the type is best exemplified by specimens from cismontane San Diego County, and we will therefore begin with the snakes of that area as the basic *humilis*. Compared with other subspecies of *humilis*, these typical *humilis humilis* have two notable characters: (1) The dorsal color is darker than that of the snakes of any other area, 7 and occasionally 9 median dorsal rows being pigmented with dark brown;[10] (2) the dorsal scale count is moderate, with a mean of 272, an interquartile range of 268 to 276, and an extreme range of 257 to 283.

On the coastal side of the mountains this snake is known to range from Santa Barbara, California, on the north, to San Ignacio, Lower California, on the south. The Lower California range may be broken by intrusions or isolated groups of *cahuilae*. As we go southward from San Diego County there seems to be a slight tendency toward an increase in dorsals and a lightening of color; northward from San Diego there may be a decrease in dorsals with little or no change in color. The specimens from outside of San Diego County are too few to prove these trends definitely; it is probable that there is little variation in these cismontane snakes from Santa Barbara, California, southeastward 350 miles at least to San José (Lat. 31°), Lower California; certainly no variation approaching that observed between *humilis humilis* and *cahuilae* as we cross the Peninsula Range in San Diego County, a distance of less than 20 miles.

Eastward of the mountains this change is quite remarkable. While we do not have available a complete series through any of the mountain passes, the altitudes are such that intergradation with *cahuilae* probably takes place at a number of places. Certainly it occurs through the San Gorgonio Pass in Riverside County; via the San Felipe into Warners, and also between Carrizo and La Posta, in San Diego County; and, further south in Lower California, at Valle Trinidad and similar passes.

Taking San Diego County specimens only, we have the following major differences between *humilis* and *cahuilae*:

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[9] Klauber, 1931, p. 343.

[10] This discussion is premised on alcoholic specimens.

CHARACTER	*Humilis*	*Cahuilae*
Color of dorsals	7-9 rows heavily pigmented with dark brown	5 rows lightly punctated with light brown
Dorsal Scale Counts		
Mean	272	293
Interquartile range	268-276	289-297
Extreme range	257-283	280-305

Of San Diego County *cahuilae,* or *cahuilae-humilis* intergrades, we have good series from two points on the desert side of the mountains: (1) from Scissors Crossing (altitude 2400 feet) to the foot of the Sentenac Canyon (altitude 1350 feet); and (2) from Yaqui Well (altitude 1270 feet), the type locality of *cahuilae,* to The Narrows (altitude 1100 feet). The first area is a rocky canyon containing a perennial stream; the second a rocky desert wash. The first area produces worm snakes which are typical *cahuilae* in dorsal scale counts, but are intermediate in color between *humilis* and *cahuilae,* there being usually 7 light brown to gray dorsal scale rows. In the Sentenac series there are three specimens which are as dark as the lightest of the cismontane *humilis,* and there is one specimen almost as light as the lightest true *cahuilae.* Thus, as we proceed down the eastern slope of the mountains, we find that the dorsal scale count changes from *humilis* to *cahuilae* first, followed by a more gradual change in color.

But to the north, through the San Gorgonio Pass, which is lower and entails a more gradual transition than the San Felipe, the characters appear to modify in the reverse order. Here, the few available specimens indicate a change to the characteristic light color of *cahuilae* first, before the increase in number of dorsal scales begins; for specimens from along Snow Creek near Whitewater, Riverside County, are almost as light as true *cahuilae,* but the dorsal scales average only 268 (7 specimens). Yet a little to the south, but higher in the mountains (at Nightingale's Ranch on the west slope of Mt. San Jacinto), we again encounter color intermediates between *humilis* and *cahuilae,* with the high dorsal scale counts of *cahuilae.*

So we have the peculiar situation that in the transition from one subspecies to the other, the two important characters in which they differ are not modified gradually and coincidentally. On the contrary, through the lowest pass the dark color of the coastal form changes quickly to the light color of the desert; but the high scale counts characteristic of the desert subspecies are acquired further eastward. But where the change takes place at higher altitudes, the high scale counts are acquired first (proceeding from west to east), while the change in color is effected later. Thus the taxonomic position of these intergrades is often likely to prove troublesome, for classification by dorsal scale counts will throw them into a different subspecies from classification by color.

As we leave the east bases of the San Jacinto and San Bernardino mountains and pass northeasterly across the Mojave Desert, we find a more gradual tendency toward change, evident in a slight increase in scale counts and reduced pigmentation. This is seen in the few specimens available from San Bernardino County, the Death Valley region of Inyo County, and the southern tip of

Nevada. These specimens show the desert tendencies of *cahuilae* in these characters but none attains the *cahuilae* extremes in either character. Until the availability of additional specimens makes a more thorough survey practicable, I believe it will be best to place the snakes of this area in the subspecies *humilis humilis*.

When we reach southwestern Utah we find *utahensis*, with scale counts as high or higher than *cahuilae*. Superficially these snakes are quite similar to the intergrades from Sentenac Canyon, in San Diego County; and, were color and scale counts the only differential characters available, I would be compelled to consider *utahensis* invalid. However, as discussed under the latter form, the Utah specimens are also characterized by a longitudinally divided fourth dorsal scale; or, if this be entire, by an exceedingly wide fifth dorsal scale, sharply contrasting with the sixth, characters not seen in the San Diego County intergrades. Therefore, *utahensis* may be recognized as a valid subspecies, probably intergrading with *humilis humilis* along the Virgin River. A single specimen from Nevada (from Boulder Dam) is tentatively placed with *humilis humilis;* it is somewhat higher in scale count and lighter in color than typical coastal specimens, but does not show the exaggerated width of the fifth dorsal characteristic of *utahensis*, although there is some increase over the fourth. This specimen is unusually attenuated (L/D=75). Additional specimens from this area should be checked for this character.

Proceeding southeast into Arizona we find the snakes of the Phoenix-Tucson area to be nearer *humilis humilis* than to any other form, and they are therefore allotted to that subspecies, unless they have 10 scale rows around the tail, in which case they are referred to *segregus*. Both the average mid-dorsals (274) and the range (263-291) are slightly higher than in typical *humilis humilis* from San Diego County (corresponding figures 272 and 257-283), thus showing some *cahuilae* tendencies, as do the snakes of the Mojave. The same is true of color, for most of the Arizona snakes have 7 medium-, or light-brown, dorsal rows. But a few, especially from the vicinity of Phoenix, are quite dark, closely approaching those from the coast. Also, from Wickenburg southeasterly, we have an increasing proportion of specimens with 10 scale rows around the tail (characteristic of *segregus*). Thus Wickenburg to Tucson is an area of intergradation with *segregus,* as discussed under the latter form. We may expect to find intergrades between *humilis humilis* and *cahuilae* between Gila Bend and Phoenix.

In this relationship between the snakes of the coast, the Colorado and Mojave deserts, and those of central Arizona we find a trend observable in a number of genera and species, wherein the forms of central Arizona are more closely related to those of the Mojave Desert, and even to cismontane southern California, than to those of the nearby Colorado Desert (Cahuilla Basin). Examples are *Lampropeltis*, *Rhinocheilus*, *Lichanura*, and *Crotalus viridis oreganus*, the last two not being present at all in the Colorado Desert basin.

Thus far only one Pacific island—Cedros—is known to harbor worm snakes, but I suspect that they will eventually be found on others, Santa Catalina and San Clemente particularly. Cedros has a high percentage of indigenous forms and the worm snake, while not differing from *humilis humilis* in either dorsal scale counts or color, does show some differences in scale arrangements. However, only two specimens are available, and one of these, being dried and of little utility, it is deemed inadvisable to suggest a taxonomic differentiation until more material becomes available.

Returning to the intergrades from the Sentenac Canyon area, in eastern San Diego County, it is interesting to observe that these snakes show the high percentage of aberrants often attributed to intergrades. Amongst these 24 specimens we find one with supraoculars, another with a supraocular on one side. Another has the anterior labials fused to the oculars, which in turn meet on the mid-dorsal line. Still another has the nasals in contact, between the rostral and the prefrontal. Altogether, they comprise an interesting series.

Locality Records.—Humilis humilis has been reported from the following localities:

LOWER CALIFORNIA: San Ignacio, San José (Lat. 31°), Cedros Island.

CALIFORNIA: *San Diego County*—Valliecitas (=Vallecito?) (type locality), San Diego, Mission Valley, Rose Canyon (=Ladrillo), La Jolla, Del Mar, Rancho Santa Fe, Chollas Heights, Alvarado Canyon, Grantville, Sunnyside, Lemon Grove, Spring Valley, Grossmont, El Cajon, Bostonia, Lakeside, Rock Creek Canyon, Bernardo, San Pasqual, 4 mi. s. of Fallbrook, Cottonwood, Dulzura, Jamul, Chocolate Creek, Viejas, El Capitan, Eagle Peak, Shady Dell, Wildwood, Ramona, Sutherland, Valley Center, Rincon, Red Mountain, Palomar; *Orange County*—Santiago Canyon (near Hot Springs); *Los Angeles County*—Chatsworth Park, Elizabeth Canyon (near Saugus), Dalton Canyon; *Santa Barbara County*—Gibralter Dam; *San Bernardino County*—San Bernardino, Slover Mountain (near Colton); *Inyo County*—Bennett's Well (Death Valley), 4 mi. n. of Furnace Creek Inn (Death Valley).

NEVADA: *Clark County*—Boulder Dam.

ARIZONA: *Maricopa County*—Stewart Mountain Dam, Phoenix, Mesa, Cave Creek Dam, 4 mi. s. of Wickenburg, 3 mi. s. of Morristown, Wittmann; *Pinal County*—Casa Grande; *Pima County*—Santa Rita Mountains, Santa Catalina Mountains, Tucson, Sabino Canyon (Santa Catalina Mountains), Sycamore Canyon (Santa Catalina Mountins).

(For localities of *humilis-cahuilae* intergrades see under *cahuilae;* also see under *cahuilae* for a discussion of keying non-coincident characters).

Leptotyphlops humilis dugesii (Bocourt)

MEXICAN WORM SNAKE

1879. *Stenostoma humile* (part), Cope, Proc. Am. Philos. Soc., Vol. 18, p. 262.
1881. *Catodon dugesii* Bocourt, Bull. Soc. Philom. (7) Vol. 6, p. 81. Type locality: Colima, Mexico. Type specimen: In Mus. Nat. d'Hist. Natur., Paris.
1882. *Siagonodon dugesii* Bocourt, Miss. Sci. Mex., Reptiles, p. 507.
1887. *Rena dugesii* Cope, Bull. U. S. Nat. Mus., No. 32, p. 64.
1891. *Rena humilis* (part) Stejneger, Proc. U. S. Nat. Mus., Vol. 14, p. 501.

1893. *Glauconia humilis* (part) Boulenger, Cat. Snakes of British Museum, Vol. 1, p. 70.
1899. *Siagonodon humilis* McLain, Contributions to Neotropical Herpetology, p. 3.
1907. *Leptotyphlops humilis* (part) Ruthven, Bull. Am. Mus. Nat. Hist., Vol. 23, p. 573.
1931. *Leptotyphlops humilis humilis* (part) Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 23, p. 340.

Distribution.—The distribution is imperfectly known at present. Specimens have been available from the Mexican states of Colima, Jalisco, Sinaloa and Guanajuato. No doubt it also occurs in the intermediate and some of the surrounding states.

Diagnosis.—A subspecies characterized by a low dorsal scale count (234-257) and the medium pigmentation of seven to nine mid-dorsal scale rows.

Material.—This description of the subspecies *dugesii* is based on three specimens seen, and partial data on three others received through correspondence.

Description.—The body is sub-cylindrical from head to tail. The head is slightly distinct; the tail is somewhat reduced in diameter and terminates in a sharp spine. Viewed from the side, the head is slightly depressed, slanting downward and forward from the interoccipital. The snout is rounded and extends considerably beyond the lower jaw, which is inset. From above, the head appears widest at the occipitals, whence it narrows forward to the nostrils and is then rounded about the snout. The longest available specimen measured 187 mm. over-all; the smallest 97 mm. The ratio of the body length to the diameter averages about 48. The ratio of the body length over-all to the tail length is about 19.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals. There are 12 rows around the tail, the reduction from 14 being at the base of the tail. The anal is entire. The mid-dorsal scale count, from rostral to tail spine (but not counting either), averages 242; extreme range 235 to 257 (235, 236, 239, 245, 257). The subcaudals number about 17.

The rostral is curved from the underside of the upper jaw over the snout, reaching back to a point even with the anterior edge of the eye. The rostral is wedge-shaped, but the posterior end is rounded. At the level of the nostril the rostral is no wider than the nasal, but is wider than the ocular.

The supralabial series comprises (besides the rostral) 4 scales on each side: an inferior nasal, an anterior supralabial, an ocular, and a posterior supralabial.

The nasal is divided into two parts, a superior and an inferior, by a suture through the nostril. The suture is directed upward as it approaches the rostral. The superior nasal is larger than the lower part; it narrows toward the prefrontal, which prevents a contact with its fellow on the other side. The inferior nasal narrows at the lip; it is widest at the top. The anterior supralabial is higher than wide; it has the appearance of having been cut out of the nasal, as the posterior edge of the superior nasal is a continuation of the same edge of the anterior supralabial. The ocular is narrower than the nasal or rostral; it narrows somewhat at the lip. The eye is anterior to the center of the ocular; it appears as a black spot beneath the skin, the surface of which is not raised by reason of the presence of the eye. The posterior supralabial is about as high as wide, triangular, but with the apex cut off. It takes up more lip space than any other scale except the rostral.

The parietals are large, more than twice as long as wide; they contact the posterior supralabials. The occipitals are of about the same size, except that they are somewhat narrowed ventro-laterally. A small temporal, the beginning of a body scale-row, is interposed between each occipital and the posterior supralabial on that side.

Of the mid-dorsal series, the prefrontal is the smallest; the three scales following are of substantially equal size.

The mental is small and triangular. There are 4 infralabials on each side. The chin-shields are much smaller than the ventrals, into which they intergrade immediately behind the head.

The scales of the top and sides of the head are dotted with tiny pits.

The 7 median dorsal scale rows are medium-brown (alcoholic colors). Occasionally 9 rows are pigmented. The head is brown above, but the rostral and nasals are somewhat lighter. Below the dorsal brown, the sides and belly are cream or light buff.

Taxonomic Status and Relationships.—The nomenclatorial situation with respect to *L. h. dugesii* and *L. h. tenuiculus* must, for the present, remain uncertain because of the European situation and the resultant impossibility of securing essential data on the type of *dugesii* in the Paris Museum. Geographically, the two nearest specimens to the type locality of *dugesii* (Colima), are USNM 49,632 from Talpa, Jalisco, and USNM 48,737 from Guanajuato. Both of these specimens have 12 scale rows around the tail. I have therefore assumed that the type of *dugesii* likewise has 12 rows; and, as the type of *tenuiculus* has only 10, I have considered the latter a valid subspecies. If the future should disclose an error in this supposition, and the type of *dugesii* has only 10 scale rows around the tail, then *tenuiculus* will become a synonym of *dugesii*, and the snakes from Guanajuato, Jalisco, and southern Sinaloa having 12 scale rows should be assigned a new subspecific name. It should be understood that the description of *dugesii* given above, and the succeeding remarks are all premised on the correctness of the guess respecting the type; if this guess is wrong, then these data are really applicable to the new, undescribed subspecies.

Dugesii is the most southerly known subspecies of *humilis* and has the lowest dorsal scale counts, with the exception of *tenuiculus*. It seems to be most closely allied to *slevini* of extreme southern Lower California, although further collecting in Sonora and Chihuahua may disclose intergradation with either *humilis humilis* or *tenuiculus*, or both, with a gradual increase in the number of dorsals as the U. S. border is approached.

Locality Records.—Dugesii has been collected at the following places in central Mexico: Colima, Colima; Talpa, Jalisco; Mazatlán and Presidio, Sinaloa; and Guanajuato, Guanajuato.

Leptotyphlops humilis slevini Klauber

SAN LUCAN WORM SNAKE

1861. *Stenostoma humile* (part) Cope, Proc. Acad. Nat. Sci. Phila., Vol. 13, p. 305.
1887. *Rena humilis* Cope, Bull. U. S. Nat. Mus., No. 32, p. 64.
1893. *Glauconia humilis* (part) Boulenger, Cat. Snakes of British Museum, Vol. 1, p. 70.
1907. *Leptotyphlops humilis* (part) Ruthven, Bull. Am. Mus. Nat. Hist., Vol. 23, p. 573.
1917. *Siagonodon humilis* (part) Stejneger and Barbour, Check List N. Amer. Amph. Rept., p. 73.
1931. *Leptotyphlops humilis slevini* Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 23, p. 338. Type locality: La Paz, Baja California, Mexico. Type specimen: CAS 53,721, collected by J. R. Slevin, June 2, 1921.

Distribution.—Extreme southern Baja California, Mexico.

Diagnosis.—A subspecies of *humilis humilis* characterized by dorsal scale counts of 244–269 and only 5 lightly-pigmented scale rows.

Material.—This description of the subspecies *humilis slevini* is based on examination of 13 specimens from the Cape Region of Lower California.

Description.—The body is almost cylindrical from head to tail. The head is slightly distinct; the tail is somewhat reduced in diameter and terminates in a sharp spine. Viewed from the side the head is moderately depressed and slants forward and downward from the interoccipital. The snout is rounded, but somewhat less so than in *humilis humilis;* it extends considerably beyond the lower jaw, which is inset. Viewed from above the head is widest at the occipitals, whence it narrows forward to the nostrils and is then curved about the snout. There is a flattened area at the eye and a slight bulge at the nostril. The longest available specimen measures 253 mm. over-all; the smallest 91 mm. The ratio of the body length to the diameter averages about 49. The ratio of the body length over-all to the tail length is about 23.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals, except that the mid-dorsals are somewhat widened on the neck. There are 12 rows around the tail, the reduction from 14 occurring at the base of the tail. The anal is somewhat pointed and is entire. The mid-dorsal scale count, from rostral to tail spine (but not counting either), averages 253; extreme range 244 to 269. The counts in twelve available specimens are 244 (2), 246, 247, 250, 251 (2), 253, 257, 259, 268, 269. The subcaudals average 15, the extreme range being 12 to 18.

The rostral is curved from the underside of the upper jaw over the snout, not reaching back to a point even with the anterior edge of the eye. The rostral is wedge-shaped, but the posterior end is broadly rounded. At the level of the nostril the rostral is considerably wider than either the nasal or ocular.

The supralabial series comprises (besides the rostral) 4 scales on each side: an inferior nasal, an anterior supralabial, an ocular, and a posterior supralabial. The nasal is divided into two parts, a superior and an inferior, by a suture through the nostril. The suture is directed upward as it approaches the rostral. The superior nasal is larger than the lower part; it narrows as it approaches the prefrontal, which prevents a contact with its fellow on the other side. The inferior nasal narrows as it approaches the lip; it is widest at the top. The anterior supralabial is higher than wide; it is pointed at the top, with the point on the posterior edge. The ocular is the largest head scale, excepting the rostral. It narrows somewhat as it approaches the lip. The eye is anterior to the middle of the ocular; it appears as a black spot beneath the skin, the surface of which is not raised by reason of its presence. The posterior supralabial is about as high as wide, triangular, but with the apex cut off. It occupies more lip space than any other scale except the rostral.

The parietals are large, more than three times as long as wide; they contact the posterior supralabials. The occipitals are of about the same size, except that they are somewhat narrowed ventro-laterally. A temporal is interposed between each occipital and the posterior supralabial on that side.

Of the mid-dorsal series the first four scales (prefrontal to interoccipital inclusive) are substantially equal in size. Posteriorly, on the neck, the scales of the mid-dorsal series are somewhat widened transversely.

The mental is small and triangular. The infralabials number 4 on each side. The chin-shields are much smaller than the ventrals into which they merge immediately behind the head.

The scales of the top and sides of the head, as far back as the parietals, are dotted with tiny pits.

The 5 median dorsal scale rows are medium to light brown (alcoholic colors). The color is applied by means of many tiny punctations. Often the scales appear to be darker on the edges. The color below is tan or cream; there is less contrast than in *humilis humilis*. The head is brown above but the rostral, lips, and under-jaw are light.

Taxonomic Status and Relationships.—Slevini falls between *dugesii* and *humilis humilis* in dorsal scale counts; and between *dugesii* and *cahuilae* in color. It probably intergrades with *humilis humilis* between La Paz and San Ignacio, but nevertheless is most closely related to *dugesii*, from which it is not strongly differentiated. Such a relationship between the Cape Region forms and those of adjacent mainland Mexico are frequent, examples being found in *Lichanura*, *Phyllorhynchus*, *Trimorphodon*, and *Crotalus* (*cinereous* group). Worm snakes should be present from La Paz north to San Ignacio; and, because of the changing ecological conditions in this area, we may expect a considerable variation in them, exemplified by diverse dorsal scale counts and colors.

Locality Records.—Slevini has been collected at the following localities, all in the Cape Region of Baja California: La Paz (type locality), Cape San Lucas, Eureka, San José del Cabo, Santa Anita, San Francisquito, and Sierra de la Laguna.

Leptotyphlops humilis cahuilae Klauber

Desert Worm Snake

1861. *Stenostoma humile* (Part) Cope, Proc. Acad. Nat. Sci. Phil., Vol. 13, p. 305.
1891. *Rena humilis* (part) Stejneger, Proc. U. S. Nat. Mus., Vol. 14, p. 501.
1893. *Glauconia humilis* (part) Boulenger, Cat. Snakes of British Museum, Vol. 1, p. 70.
1907. *Leptotyphlops humilis* (part) Ruthven, Bull. Am. Mus. Nat. Hist., Vol. 23, p. 573.
1912. *Siagonondon humilis* Van Denburgh, Proc. Cal. Acad. Sci., Ser. 4, Vol. 3, p. 153.
1931. *Leptotyphlops humilis cahuilae* Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 23, p. 339. Type locality: Yaqui Well, San Diego County, California. Type specimen: LMK 2637.

Distribution.—The Colorado and Yuma deserts of southeastern California and southwestern Arizona. Probably also present, but not yet reported, in northeastern Lower California and extreme northwestern Sonora, Mexico. It also occurs in the Vizcaíno Desert of central Lower California.

Diagnosis.—A subspecies characterized by high dorsal scale counts (280 to 305), and the lightest color of all the subspecies, only 5 of the mid-dorsal scale rows being faintly dotted with brown.

Material.—I have had available for examination 16 specimens from the type locality and nearby points at the eastern base of the Peninsula Range; 11 from the Yuma area; 4 from desert areas in Riverside and San Bernardino Counties; and 3 from the Vizcaíno Desert in central Lower California. In addition, I have a series of 24 *humilis-cahuilae* intergrades from the Sentenac Canyon region of San Diego County; and 9 intergrades from farther north at the foot of Mt. San Jacinto, or on the mountain slopes.

Description.—This description of the subspecies *humilis cahuilae* is based on 16 specimens from near the type locality in eastern San Diego County, and 11 from the vicinity of Yuma, Arizona. Specimens from areas showing intergradation with *L. humilis humilis* have been omitted from consideration in describing the typical form.

The body is substantially cylindrical from neck to tail. The head is slightly distinct; the tail is somewhat reduced in diameter and terminates in a spine. Viewed from the side the head is moderately depressed and slants downward from the interoccipital forward. The snout is rounded and extends considerably beyond the lower jaw, which is inset. From above the head is widest at the occipitals, whence it narrows forward to the nostrils and is then rounded about the snout. There is a slight indentation just anterior to the eye. The longest available specimen—one from Yuma, Arizona—measures 389 mm. over-all; this is the largest worm snake of the genus *Leptotyphlops* that I have seen from any place in the Americas. Specimens exceeding 300 mm. probably represent about 10 per cent or more of the population. The smallest available individual measures 119 mm. The ratio of the body length to the diameter averages about

60; half the specimens will fall between 55 and 65. There seems to be a slight difference between the snakes of the Yaqui Well and Yuma districts in this character, the latter being somewhat slimmer. The ratio of the body length over-all to the tail length is about 22; half the specimens will fall between 20.5 and 23.5.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals. There are 12 rows around the tail, the reduction from 14 being at the base of the tail. The anal is entire. The mean of the mid-dorsal scale count, from rostral to tail spine (but not counting either) is 294.68∓1.37; extreme range 280 to 305; interquartile range 290.1 to 299.3; coefficient of variation 2.36 per cent. The subcaudals average 17.38∓0.31; extreme range 16 to 21; interquartile range 16.34 to 18.41; coefficient of variation 8.81 per cent.

The rostral is curved from the underside of the upper jaw over the snout, reaching back sometimes to a point even with the anterior edge of the eye, but usually not so far. It never reaches the center of the eye. The rostral is wedge-shaped, but the point is rounded. Occasionally the rostral barely touches the prefrontal, so that the superior nasals almost meet. At the level of the nostril the rostral is wider than the nasal and slightly wider than the ocular.

The supralabial series comprises (besides the rostral) 4 scales on either side: an inferior nasal, an anterior supralabial, an ocular, and a posterior supralabial.

The nasal is divided into two parts, a superior and an inferior, by a suture through the nostril. The suture is directed upward as it approaches the rostral, and the nostril is somewhat nearer the rostral than the ocular. The superior nasal is larger than the lower part; it narrows as it approaches the prefrontal, which prevents a contact with its fellow on the other side, although the two nasals sometimes almost meet. The inferior nasal narrows as it approaches the lip, it is widest at the nostril. The anterior supralabial is higher than wide; it is pointed at the top, with the posterior edge longer than the anterior. The ocular is the largest head scale, excepting only the rostral. It narrows somewhat as it approaches the lip. The eye is located somewhat forward of the ocular; it appears as a black spot beneath the skin, the surface of which is not raised by reason of the presence of the eye. The posterior supralabial is about as high as wide, triangular, but with the apex truncated. It occupies more lip space than any other scale except the rostral.

The parietals are large, more than twice as long as wide; they have a wide contact with the posterior supralabials. The occipitals are of about the same size as the parietals, except that they are somewhat narrowed ventro-laterally. A small temporal is interposed between each occipital and the posterior supralabial on that side.

Of the mid-dorsal series there is usually an increase in size from the prefrontal, through the frontal, to the interparietal. The interoccipital is usually about equal to the interparietal or somewhat smaller. The succeeding mid-dorsal scales are often widened across the body and narrowed in a longitudinal direction.

The mental is small, triangular, and indented to form an avenue for the tongue. The infralabials are difficult to see, since they are hidden by the overhanging upper jaw; there are 4 on each side. The chin shields are much smaller than the ventrals with which they intergrade immediately behind the head.

The scales of the top and sides of the head are dotted with tiny pits.

This is much the lightest of our North American worm snakes. Many specimens appear almost white (in alcohol), yet a close examination will show the 5 median dorsal scale rows to be faintly punctated with light brown. Usually the scales are without stippling on the edges. Below the color is cream to white; specimens from Yuma often have a pinkish tinge. The head is the color of the ventral surface. The eye is black, in sharp contrast to the head and body colors.

Taxonomic Status and Relationships. Intrasubspecific Variations.—This subspecies, characterized by its high dorsal scale count and light color, in its most typical areas, is a well differentiated form. It comprises an intrusion from the south, via the basin of the lower Colorado River, into the territory of *L. humilis humilis*. On the edges of this basin there are areas of intergradation in which there is a considerable variability, representing different combinations of the several characters in which the two subspecies differ. These variations are discussed under *humilis humilis*. Their peculiar nature suggests that the two subspecies may have been separated geographically for a considerable time (by ancient Lake Cahuilla, for example) during the period of differentiation, and may then have recontacted and interbred. If we designate the dorsal scale count and color characters by capital and lower case letters respectively, *humilis humilis* being Aa and *cahuilae* Bb, we have the peculiar situation that some of the intergrades are Ab while in other areas they are aB. In still others they seem about halfway between in both characters.

A practical problem arises in the preparation of a key, as to how the two characters distinguishing *cahuilae* from *humilis humilis* shall be manipulated, since in the intergrading area they do not change simultaneously. I favor the use of color and pattern as the primary character, relegating the dorsal scale counts to a secondary place. This is not because the latter are less important but because the former are so much easier to determine. Keying in this manner will place mountainside specimens from such points as Scissors Crossing, Sentenac Canyon and Nightingale's in the subspecies *humilis*, notwithstanding their high dorsal counts; while those from near Whitewater would probably be allocated to *cahuilae*. This method will also simplify the classification of the specimens from around Phoenix and Tucson, a few of which have dorsal counts above 280. But one must be careful that the color (or its absence) is normal for preserved material and not produced by artificial fading. If there be doubt it is best to fall back on the scale count.

I have had cause to regret the selection I made of the type of *cahuilae*. Yaqui Well, the type locality, is only 3 miles from Sentenac Canyon, where intermediates occur; and although the color of the type specimen is typical of the subspecies as now known, the dorsal scale count is low, 282, compared to a subspecific average of 295. It would have been better to have chosen a type from The Narrows, farther out on the desert, or even from across the Cahuilla

Basin at Yuma; for the specimens from those points differ more widely and uniformly from *humilis humilis.*

There is no significant difference in dorsal scale counts between the snakes of the Yaqui Well and Yuma areas. There may be a slight color difference, as the Yuma specimens are somewhat pinker; however, I am not sure on this point, since the methods of preservation were not exactly the same in the two lots. Radiating out from these areas there is a tendency toward fewer dorsal scales and more dorsal pigmentation; the latter is manifested both in more rows pigmented, and darker color.

There is little possibility that the snakes of the Vizcaíno Desert in Lower California are territorially connected with those of the Yuma and Colorado deserts, although extensions from the latter might be expected as far south as Punta San Felipe or Punta San Fermin, on the Gulf Coast of Lower California. Thus this isolated group in the Vizcaíno Desert either represents a residue of a former intrusion from Sonora, or a development from the surrounding *humilis humilis* under the same ecological conditions that have produced *cahuilae* in the other desert.

Locality Records.—Cahuilae, in its typical form, has been collected at the following places:

LOWER CALIFORNIA: San Angelo (Vizcaíno Desert).

CALIFORNIA: *San Diego County*—Yaqui Well (type locality), 1 mi. w. of Yaqui Well, The Narrows (also 4 mi. w., 1 mi. w., and 1 mi. e.), San Felipe Wash (indefinite), Agua Caliente Spring (near Vallecito), Borego Palm Canyon; *Riverside County*—8 mi. e. of Desert Center; *San Bernardino County*—Needles.[11]

ARIZONA: *Mohave County*—Fort Mohave; *Yuma County*—Yuma,[12] Somerton; *Maricopa County*—Gila Bend.

I would characterize as *humilis-cahuilae* intergrades, specimens from the following localities in California: *San Diego County*—Banner (might be pure *humilis*), Scissors Crossing, Sentenac Canyon, Tubb's Canyon; *Riverside County*—Snow Creek near Whitewater, Nightingale's (and 3 mi. n.), County Line s. of Morongo; *San Bernardino County*—Newberry Spring, Morongo Valley.

Leptotyphlops humilis utahensis Tanner

UTAH WORM SNAKE

1935. *Siagonodon humilis* Tanner, Proc. Utah Acad. Sci. Arts and Letters, Vol. 12, p. 267.

1938. *Leptotyphlops humilis utahensis* Tanner, Proc. Utah Acad. Sci. Arts and Letters, Vol. 15, p. 149. Type locality: Saint George, Washington

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[11] A poor specimen, possibly should be allocated to *humilis.*

[12] Some of the early Yuma specimens are recorded from Fort Yuma and may have come from the California side of the river, in what is now Imperial County. While this paper was in press several specimens of this subspecies were collected at Potholes, Imperial County, California, by Wallace F. Wood. They are typically *cahuilae,* except that some have 7, rather than 5 lightly-pigmented dorsal scale rows.

County, Utah. Type specimen: BYU 662, collected by V. M. Tanner and A. Paxman, April 28, 1938.

Distribution.—At present only known to occur in Washington County, extreme southwestern Utah.

Diagnosis.—A subspecies characterized by a high dorsal scale count (289–308), the medium pigmentation of seven mid-dorsal scale rows, and a proportion of transversely divided interoccipital (fourth dorsal) scales; or if the fourth dorsal is not divided, the fifth is very much wider than the sixth (fig. 8).

Material.—This description of the subspecies *humilis utahensis* is based on 10 specimens from the Saint George area in extreme southwestern Utah, which is the type locality. These were loaned to me through the courtesy of Dr. Vasco M. Tanner and Mr. Ross Hardy.

Description.—The body is almost cylindrical from head to tail. The head is somewhat distinct, more so than in other *humilis* subspecies; the tail is reduced in diameter and terminates in a sharp spine; it appears to taper more gradually than in the other subspecies of *humilis*. Viewed from the side the head is moderately depressed and slants forward and downward from a point back of the interoccipital. The snout is rounded and extends considerably beyond the lower jaw, which is inset. Viewed from above the head is widest at the occipitals, whence it narrows forward to the nostrils and is then rounded about the snout. There is a slight indentation anterior to the eye. The longest available specimen measures 322 mm. over-all; the smallest 114 mm. The ratio of the body length to the diameter (adults only) averages about 63. The ratio of the adult body length over-all to the tail length is about 21.5.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals (except on the neck) or mid-ventrals. There are 12 rows around the tail, the reduction from 14 being at the base of the tail. The anal is entire; it may be pointed or have a straight posterior edge. The mid-dorsal scale count, from rostral to tail spine averages 300; extreme range 289 to 308. (The counts in the ten available specimens are 289, 292, 295, 299, 301 (2), 303, 305 (2), 308). The subcaudals average 18; extreme range 17 to 20.

The rostral is curved from the underside of the upper jaw over the snout; it does not reach as far back as the eye. The posterior end is rather pointed and the contact with the prefrontal is narrow. At the level of the nostril the rostral is wider than either the nasal or ocular.

The supralabial series comprises (besides the rostral) 4 scales on either side: an inferior nasal, an anterior supralabial, an ocular, and a posterior supralabial. The nasal is divided into two parts, a superior and an inferior, by a suture through the nostril. The suture is directed upward as it approaches the rostral; the nostril is nearer the rostral than the ocular. The superior nasal is larger than the lower part; it narrows toward the prefrontal, which barely prevents a contact with its fellow on the other side. The inferior nasal narrows as it approaches the lip, it is widest below the nostril. The anterior supralabial is slightly higher than wide; it does not reach the level of the eye; it has the appearance of having been cut out of the nasal, as the posterior edge of the superior nasal is a continuation of the same edge of the anterior supralabial. The posterior edge of the anterior supralabial is longer than the other edge. The ocular is the largest head scale, excepting only the rostral. It narrows somewhat toward the lip. The eye is centered in the ocular; it appears as a black spot beneath the skin, the surface of which is not raised by reason of the presence of the eye. Around the black spot is a light ring. The posterior supralabial is about as high as wide, triangular, but with the apex cut off. It occupies more lip space than any other scale except the rostral.

The parietals are large, more than twice as long as wide; they contact the posterior supralabials. The occipitals are of similar size except that they are somewhat narrowed ventro-laterally. A small temporal, the beginning of a body scale row (the third below the mid-dorsal row), is interposed between each occipital and the posterior supralabial on that side.

Of the mid-dorsal series the prefrontal and the frontal are usually of equal size; sometimes the interparietal is of similar size, sometimes larger than the scales anterior to it. The interoccipital is always larger than the interparietal, and, in 6 specimens out of 10, is divided in two by a longitudinal suture, this being characteristic of *utahensis* as compared with other *humilis* subspecies. The succeeding scales of the mid-dorsal series on the neck are widened transversely. The fifth scale is usually distinctly wider than the sixth (fig. 8).

The mental is narrow and triangular, and is indented to form an opening for the tongue. The infralabials are hidden by the overhanging upper jaw; there are 4 on each side. The chin-shields are much smaller than the ventrals, into which they merge immediately behind the head.

The scales of the top and sides of the head are dotted with tiny pits.

The 7 median dorsal scale rows are light grayish-brown (alcoholic colors). The color is applied by means of stippling. Often the scales appear to be lighter on the edges; this seems to depend somewhat on the condition of the skin with respect to shedding and is probably due to the overlapping of the scales. Below the color is cream or tan.

Taxonomic Status and Relationships.—*Utahensis* is clearly an off-shoot of *humilis humilis*, with *cahuilae* tendencies evident in the high dorsal scale count. In fact, in most characters, including scale counts and pigmentation, it is quite similar to the *humilis-cahuilae* intergrades which occur in Sentenac Canyon and at Scissors Crossing in eastern San Diego County, California. These localities are 3 to 6 miles from the type locality of *cahuilae*. Similar mediumly-pigmented specimens with high dorsal counts are found elsewhere on the eastern slope of the Peninsula Range in southern California—for example, at Nightingale's in Riverside County—so *utahensis* can hardly be validated on the characters contained in the original diagnosis. But I find that it can often be segregated by a split interoccipital which the *humilis-cahuilae* intergrades lack; this character is present in 6 out of 10 specimens of *utahensis*, and in none out of more than 100 *humilis humilis* or *h. cahuilae*. Where this character is absent it is observed that the fifth dorsal is very much wider than the sixth, a condition absent in the other subspecies, or present to a less conspicuous extent. Hence I would recognize this as a valid form.

Locality Records.—Thus far *utahensis* has been collected only at Saint George and Santa Clara, Washington County, Utah, these being the only points in Utah from which any specimens of *Leptotyphlops* have been recorded. Territorially, the nearest specimen to the locality where *utahensis* is found is one collected near Boulder City, Nevada. This specimen is nearer *humilis humilis* than *utahensis;* the dorsal scale count is intermediate, but the fourth dorsal is not divided, nor is the fifth conspicuously widened. Probably intergrades between *humilis humilis* and *utahensis* will eventually be found along the Virgin River.

Leptotyphlops humilis segregus Klauber

TRANS-PECOS WORM SNAKE

1922. *Siagonodon humilis* (part) Schmidt, Bull. Am. Mus. Nat. Hist., Vol. 46, Art. 11, p. 682.

1931. *Leptotyphlops humilis humilis* (part) Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 23, p. 340.

1939. *Leptotyphlops humilis segregus* Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 9, No. 14a, p. 67. Type locality: Chalk Draw, Brewster County, Texas. Type specimen: USNM 103,670, collected by T. F. Smith, August 11, 1936.

Distribution.—The trans-Pecos region of Texas, northern Coahuila, and southeastern Arizona. To be expected in southwestern New Mexico and northern Chihuahua.

Diagnosis.—A subspecies of *L. humilis* having only 10 scale rows around the tail, whereas all others except *tenuiculus* have 12. From *tenuiculus* it is distinguished in having a higher number of dorsal scales; *segregus* has more than 250, *tenuiculus* less.

Material.—This description of the subspecies *L. humilis segregus* is based on 5 specimens from trans-Pecos Texas and 2 from Coahuila, Mexico. No Arizona specimens have been used, since southeastern Arizona, where they occur, is an area of intergradation with *L. humilis humilis.*

Description.—The body is almost cylindrical from head to tail. The head is slightly distinct; the tail is somewhat reduced in diameter and terminates in a sharp spine. From the side the head is moderately depressed and slants downward from the frontal forward. The snout is rounded and extends considerably beyond the lower jaw, which is inset. Viewed from above the head is widest at the occipitals, whence it narrows forward to the nostrils and is then rounded about the snout; in the largest specimens there is an indentation at the eyes. The longest available specimen measured 319 mm. over-all. The ratio of the body length to the diameter averages about 58. The ratio of the body length over-all to the tail length is about 22.

The body is covered with 14 rows of smooth and imbricate scales of substantially uniform size, there being no conspicuous enlargement of either mid-dorsals or mid-ventrals. There are 10 rows around the tail, the first reduction to 12 being produced by the suppression of the fourth row above the mid-ventral on each side; the final change to 10 occurs at the base of the tail. The anal is entire and is somewhat pointed. The mid-dorsal scale count, from rostral to tail spine (but not counting either), averages 271; extreme range 261 to 275, the actual counts being 261, 271, 272, 274, 275 (2). The subcaudals average 14; extreme range 12 to 16.

The rostral is curved from the underside of the upper jaw over the snout; in some specimens it reaches back to a point even with the anterior edge of the eye, but not so far in others. It never reaches the center of the eye. The rostral is wedge-shaped, but the posterior end is rounded where it engages the prefrontal. At the level of the nostril the rostral is wider than either the nasal or ocular.

The supralabial series comprises (besides the rostral) 4 scales on each side: an inferior nasal, an anterior supralabial, an ocular, and a posterior supralabial.

The nasal is divided into two parts, a superior and an inferior, by a suture through the nostril. The suture is directed upward as it approaches the rostral; the nostril is nearer the anterior, than the posterior end of the suture. The superior nasal is larger than the lower part; it narrows as it approaches the prefrontal, which prevents a contact with its fellow on the other side. The inferior nasal narrows as it approaches the lip, it is widest below the nostril. The anterior supralabial is higher than wide; it has the appearance of having been cut out of the nasal, as the posterior edge of the superior nasal is a continuation of the same edge of the anterior supralabial. The ocular is the largest head scale, excepting only the rostral. It narrows somewhat toward the lip. The eye is at the center of the ocular, or somewhat in advance; it appears as a black spot beneath the skin, the surface of which is not raised by reason of its presence. Around the black spot is a light ring. The posterior supralabial is about as high as wide, triangular, but with the apex cut off. It takes up more lip space than any other scale except the rostral.

The parietals are large, about 3 times as long as wide; they contact the posterior supralabials. The occipitals are slightly shorter and are somewhat narrowed ventro-laterally. A small temporal, the beginning of a body scale row, is interposed between each occipital and the posterior supralabial on that side.

Of the mid-dorsal series the prefrontal is usually larger than the frontal (the opposite is true in *humilis humilis*), followed by an increase in the interparietal, which is usually equal in size to the interoccipital. These four scales on the head are all narrower than the mid-dorsal row on the body.

The mental is small and triangular. The infralabials are difficult to see, since they are hidden by the overhanging upper jaw; there appear to be 4 on each side. The chin-shields are much smaller than the ventrals, into which they merge on the neck.

The scales of the top and sides of the head are dotted with tiny pits as far back as the occipitals.

The 7 median dorsal scale rows are medium to dark brown (alcoholic colors), the two specimens from Coahuila being considerably darker than those from Texas. Close examination shows the color to be applied by means of many small dots, very close together.

The head is brown above but the lips are usually light; the under-jaw is always light. There are often light scales in the temporal series. Below the dorsal brown, the sides and belly are cream or light buff. In the Fort Clark, Texas, and Coahuila specimens the anal is strongly punctated with brown.

Taxonomic Status and Relationships.—*Segregus* is most closely allied to *tenuiculus,* and to *humilis humilis* and may indeed be the ancestral form of the latter. Ten rather than 12 scale rows around the tail is a more general condition in American *Leptotyphlops,* and, in this, *segregus* follows what is probably the primitive formula.

The situation in south-central and southeastern Arizona, where worm snakes are found both with 10 and 12 scale rows around the tail, is subject to alternative interpretations: either the two forms represent a single intergrading population (as the subspecific relationship which I have used implies); or they comprise separate overlapping species. Thus far I have been unable to find any other difference paralleling that in the caudal rows.

There is a difference between the dorsal scale counts of those having 12 rows around the tail and those having 10, for 18 specimens of the former average 274.9, while 6 specimens of the latter have a mean of 268.5. However, this difference is below the usually accepted level of significance since, by the *t*-test, P (the probability that the samples are drawn from a single population) falls between 0.2 and 0.1. In tests of this kind 0.05 is usually accepted as indicating a significant difference.

The subcaudals do show a significant difference, for the 12-row snakes average 17.87, and the 10-row, 14.71, and from the *t*-test we find $P = 0.001$. But there is a possibility of sexual dimorphism here which must not be overlooked. In other populations of worm snakes, for example, in *humilis humilis* in California and in *dulcis dulcis* in Texas, the tail rows are constant. But we might well suppose that in an area where this character was unstable the males would tend to have 12 rows and the females 10; and with this would also go the normal tendency of the males to have a greater number of subcaudals than the females. So there would be an intrasubspecific correlation between tail rows and subcaudals, and hence a difference of the type here found would be explained by sexual dimorphism rather than true specific differentiation. For this reason I do not view the difference between the subcaudals in *humilis humilis* and *segregus* in southeastern Arizona as indicating specific overlapping, rather than subspecific intergradation, unless verified by other differences.

I have been able to find no difference in scale arrangements. Furthermore, it is probably significant that the individuals of *humilis humilis* (i.e. 12 tail-row specimens) found in the vicinity of Wickenburg are darker in color than those at Tucson, and the same situation is found to be true of *segregus,* that is, the snakes with 10 tail rows.

The same intermediate character of both the 10- and 12-row snakes from southeastern Arizona is noted with respect to the relative sizes of the first four mid-dorsal scales on the head. In *humilis humilis* from the Pacific Coast the trend is usually $1 < 2 < 3 > 4$, the first scale (prefrontal) being nearly always the smallest of the series. In *segregus* from Texas and Coahuila the prefrontal is larger than the frontal, the order generally being $1 > 2 < 3 = 4$. In the Arizona specimens, whether following *humilis* or *segregus* in tail rows, the prefrontal and frontal are about equal, with the next two scales slightly larger. Thus there is a suggestion here of intergradation, rather than the overlapping of two separate forms.

So, for the present, while the specific separation of *humilis* and *segregus* is by no means impossible, we are justified in assuming that the scale rows around the tail are a variable character in this part of Arizona, which is therefore the area of intergradation between two subspecies, rather than an overlapping of two separate species. So far, no specimen with 10 rows has been found west of Wickenburg, and none with 12 east of Tucson. From this area of intergradation I have seen 8 specimens with 10 rows and 21 with 12.

Taking only the Arizona specimens of *segregus* we find the mean dorsal scale count to average 268.5 (range 254 to 280) and the subcaudals 14.7 (13 to 17). Hence, with the relatively few specimens available, we cannot prove a significant difference between these western representatives and those from Texas and Coahuila.

Locality Records.—Segregus has been reported from the following localities:

TEXAS: *Brewster County*—Chalk Draw, 15 mi. sw. of Marathon, 65 mi. s. of Alpine; *Reeves County*—Weinacht's Draw near Phantom Lake; *Kinney County*—Fort Clark.

COAHUILA: El Capoline (Sierra de Santa Rosa, 5000 ft.), Rancho de la Babia (Sierra del Carmen, near Tanque de la Tapon, 3000 ft.).

ARIZONA: *Maricopa County*—4 mi. s. of Wickenburg; *Pima County*—Tucson; *Cochise County*—Benson.

Leptotyphlops humilis tenuiculus (Garman)

SAN LUIS POTOSI WORM SNAKE

1883. *Stenostoma tenuiculum* Garman, Mem. Mus. Comp. Zoöl., Vol. 8, No. 3, p. 5. Type locality: San Luis Potosí, Mexico. Type Specimen: MCZ 4519.
1887. *Rena tenuicula* Cope, Bull. U. S. Nat. Mus., No. 32, p. 91.
1891. *Rena humilis* (part) Stejneger, Proc., U. S. Nat. Mus., Vol. 14, p. 501.
1893. *Glauconia humilis* (part) Boulenger, Cat. Snakes of British Museum, Vol. 1, p. 70.
1907. *Leptotyphlops humilis* (part) Ruthven, Bull. Am. Mus. Nat. Hist., Vol. 23, p. 573.
1931. *Leptotyphlops humilis humilis* (part) Klauber, Trans. S. D. Soc. Nat. Hist., Vol. 6, No. 23, p. 340.

Status.—The validity of *tenuiculus* depends upon the correctness of the assumption that the type of *L. h. dugesii* has 12 scale rows around the tail, a fact which cannot now be determined because of the European situation. If *dugesii* should, in fact, have only 10 rows, then *tenuiculus* is probably a synonym of *dugesii*, as discussed on p. 131.

Distribution.—At present known only from the type locality, San Luis Potosí.

Diagnosis.—A subspecies of *L. humilis* distinguished from all other subspecies, except *segregus*, by having 10 scale rows around the tail. From *segregus* it differs in having less than 250 mid-dorsal scales, whereas the latter exceeds 250 and averages 270.

Description.—Since this subspecies is known only from the type specimen, which I have not seen, I can give only a brief description from data kindly supplied by Mr. Benjamin Shreve and from the original description by Garman.

The body is substantially cylindrical. The head is indistinct, slightly depressed and rounded at the snout; the tail ends in a spine. The lower jaw is inset. The eye is small and distinct. The rostral reaches almost as far back as the eye. The nasal is divided. The supralabial series comprises four scales on each side: an undivided anterior supralabial, an inferior nasal, an ocular, and a posterior supralabial. There are no supraoculars. The scales are smooth and imbricate; the mid-ventral row is slightly enlarged.

There are 14 scale rows around the body, and 10 around the tail. The mid-dorsal series numbers 244, and the subcaudals 14. The length over-all is 117 mm., the tail length 6 mm., and body diameter 2½ mm. The seven central dorsal scale-rows are grayish-brown; the ventral color is white.

Taxonomic Status and Relationships.—This subspecies is probably most closely related to *segregus,* from which it differs in having fewer dorsals. This is somewhat the same as the relationship between *dugesii* and *humilis humilis.*

Locality Records.—Known only from the type locality San Luis Potosí, Mexico. It is not certain whether this refers to the city or the state.

HABITS, HABITATS, AND FIELD NOTES

Our knowledge of the life histories of these small subterranean snakes is so meagre, and the habits of the several subspecies so similar, that it will be best to set forth the available data at one point rather than to scatter them among the separate subspecies.

In general, we know that these snakes, although largely subterranean in habit, and blind or almost blind, do spend a considerable time above ground at night, in favorable seasons and temperatures. Also, while they (I am referring to the *dulcis-humilis* group, and not to *albifrons* and its relatives) are inhabitants of deserts or semi-arid areas, they prefer moist spots when obtainable.

In the United States and northern Mexico, the range of these worm snakes is substantially that of the Desert Diamond Rattlesnake (*Crotalus cinereous*), and its relatives *C. ruber* and *C. lucasensis*, together with such other Sonoran forms as *Arizona elegans* and *Rhinocheilus lecontei,* and the racers, *Coluber flagellum flavigularis* and *C. f. frenatum.* In Mexico the range of this worm-snake group extends somewhat to the south of these typical Sonoran forms; and, indeed, it may later be found that *maximus* and *bressoni* range into Central America or beyond, as is indicated by certain resemblances between *bressoni* and *macrolepis.* In fact, of *maximus* and *bressoni* we know comparatively little; they may or may not be closely related to *dulcis;* our tendency to view them in that category is partly the result of their mutual differences from the *albifrons* group. Taken alone, the species *dulcis* and *humilis* have substantially the same range in Mexico as the Sonoran forms mentioned above.

At least in the greater parts of their ranges, we may visualize *dulcis* and *humilis* as inhabiting rocky and sandy deserts, chaparral-covered foothills, boulder-strewn mountain sides, and the more arid southwestern corner of the Mississippi-Basin prairies.

While not restricted to damp areas they seem definitely to prefer localities wherein some moisture is present. On the desert side of the mountains, in San Diego County, they are most plentiful in the rocky canyons where there are small streams, such as Sentenac Canyon, Tubb's Canyon, and Borego Palm Canyon. In the Yuma area they are usually found in the irrigated section between Yuma and Somerton, Arizona. They are said to be found frequently in the gardens about Tucson and Phoenix. They have not invaded all irrigated areas, for they have not yet been found in the Imperial Valley. But in spite of this liking for local moisture they are absent in territories, contiguous to those which they inhabit, where the rainfall is greater, such as, for example, eastern Texas, eastern Kansas, and coastal California north of Santa Barbara.

Burt (1935, p. 530) states that *dulcis* is a characteristic inhabitant of moderately sandy, semi-arid prairies, either in the vicinity of trees or away from them. In captivity he found that they preferred moist (but not wet) sand to dry. I have found that captive specimens will live longer in moist moss than in dry. Tanner (1938, p. 150) states that all his specimens of *utahensis* were taken in moist sandy soil. On the other hand, Mosauer (1936, p. 10) found *cahuilae* in the sand hills of the Vizcaíno Desert, which must be very dry. I have taken the same subspecies at The Narrows, normally an exceedingly arid desert, but where there is an occasional flash flood from a cloudburst. Worm snakes have not been collected in the great sand dune area west of Yuma.

Aside from the presence of dampness, rocks and boulders seem essential to the worm snakes, at least to *humilis* and its subspecies. Throughout the Cahuilla Basin, and other desert areas of the southwest, we find that worm snakes are seldom or never found on the sandy flats, dry lakes, or alluvial fans, but are usually in the rocky canyons or on mountain slopes. In this they are coterminous with such rock inhabiting forms as *Hypsiglena ochrorhynchus, Trimorphodon vandenburghi,* and *Crotalus mitchellii pyrrhus,* whose ranges are discontinuous patches throughout the desert area. Many miles of night collecting, by driving on desert roads (Klauber, 1939a), have taught us that *Leptotyphlops* does not follow *Sonora, Phyllorhynchus,* and *Crotalus cerastes* out onto the desert flats.

Daytime captures of *Leptotyphlops* are usually effected by overturning rocks or in the course of excavations. For example, in the granite-boulder area of San Diego County, *humilis humilis* is most often found under granite flakes which are exfoliating from parent boulders. They are more likely to be discovered under flakes low down on the sides of the boulders, close to, or touching the ground; or where earth has accumulated between flake and boulder. Thus they are not often found when hunting for *Xantusia henshawi* under the higher flakes. One of the best places to search for them is to locate a flake leaning against a large boulder, near the ground line, and then to dig below the flake. They may also be under flakes or stones lying on the ground, particularly where some moisture is present. Specimens of *humilis humilis* have been found under stones in this manner in every month from March to July, inclusive. One was collected under a board lying on the ground.

Worm snakes are often discovered in the course of excavations for foundations, pipe lines, post-holes, etc. Frequently several may be found together; for example, three specimens were disclosed in digging out the rotted butt of a fence post. If the soil be loose or rocky they are difficult to capture, since they are very active and burrow immediately. Major Chapman Grant, while supervising the work of a CCC camp at El Capitan, San Diego County, found one about 4 feet down and 2 feet in from the face of an earth bank. Another was located in loose soil only a few inches below the surface. On June 21st, two were found 4 feet below the surface on a side hill. A week later another was discovered at a depth of two feet, but escaped.

Burt (1935, p. 530) reports that *dulcis* is not common under surface stones in the summer, when they apparently go deeper in search of moisture. Force (1936) reports that *dissectus* is found under sandstone slabs and limestone boulders, as many as five being taken under a single boulder. If a snake succeeded in getting under a second slab it would invariably escape. One was found in a sandy ant's-nest.

Taylor (1939, p. 4), following an overflow of the Rio Grande River in Cameron County, Texas, found a number of specimens of *dulcis* on floating debris in a corn field. The water was 3 to 4 feet deep.

The finding of specimens run over on the road (DOR) suggested that these little snakes were not entirely subterranean, but must spend at least a part of their nocturnal activities on the surface. As the method of collecting by driving on desert roads at night became perfected, we found that such was indeed the case, and we began to pick up live specimens in some numbers. The technique does not differ from that involved in the collection of other small nocturnal desert snakes, except that *Leptotyphlops*, being both smaller and more translucent than any other genus, is naturally more difficult to see. Slow driving and a dark paved road are essential; and even then a good pair of eyes and a certain experience are required for success, since the quarry does not stand out in the headlights to the degree characteristic of *Phyllorhynchus* and *Sonora*. They have, in fact, a sort of ghostly appearance when the light strikes them. When the conditions, with respect to season and surroundings, are proper for success, collecting may be quite good. The best I have ever experienced was in the vicinity of Scissors Crossing and the upper Sentenac Canyon, eastern San Diego County, on the night of June 9, 1939, when 7 specimens (*humilis-cahuilae* intergrades) were caught between 7:40 P. M. and 8:30. The temperature was about 80° F.; there was a considerable breeze and no moon. The distance traveled in this 50 minute period was 7 miles, so that we averaged one worm snake per mile. Much of the success of this foray was due to my companion, Charles E. Shaw, who has an astonishing ability to see these little snakes. We got a total of 31 nocturnal snakes alive that evening and passed by several others while we were hurrying to a distant destination toward midnight.

The ability of *Leptotyphlops* to withstand heat was noted a few days later when, at Trona, we carelessly neglected to wrap the jars containing our captives in wet cloths. The result was that more than half died from the heat (we had about 40), although all were desert species such as *Phyllorhynchus decurtatus perkinsi*, *Sonora occipitalis*, *Arizona elegans occidentalis*, *Rhinocheilus lecontei*, *Crotalus cerastes*, and *C. mitchellii pyrrhus*. Of the worm snakes we lost only one out of five, a smaller proportion than of the other species.

Altogether I have found 27 worm snakes above ground at night, all but two on the desert side of the mountains. They were found in April, May, June, and September, nearly all being in May and June. The hours of collection have been as follows:

6:30–6:59	1
7:00–7:29	4
7:30–7:59	5
8:00–8:29	9
8:30–8:59	1
9:00–9:29	1

This probably does not give an entirely accurate picture of the hours of nocturnal activity, since our own operations were often discontinued at from 10 to midnight and there may be a recurrence of activity in the early morning hours. But the comparatively few specimens found after 8:30 indicate a difference from our experiences with such other nocturnal forms as *Phyllorhynchus decurtatus perkinsi* and *Sonora occipitalis*, for these do not concentrate their activities so conspicuously in the early hours of the evening (Klauber, 1939a, p. 46, table 8). As shown in the table these two snakes are quite active at least until 10; whatever deficiencies there may be in our working more intensively in the early evening would have affected our bag of these as well. Testing the hourly activities of *Phyllorhynchus* and *Sonora* against *Leptotyphlops* by the use of chi-square and an R x 2 table we find that there is a really significant difference ($P < 0.001$). Thus *Leptotyphlops* is proved to concentrate its activities more definitely in the early evening hours than do these other desert species.

Worm snakes have been found active with desert air temperatures as low as 64° and as high as 88° F. The optimum temperature seems to be about 78°–82°. They do not appear to mind a strong wind blowing.

The monthly distributions previously given comprised only live specimens found above ground at night. Including specimens found under stones, in excavations, and DOR we have the following statistics of *humilis humilis* and *h. cahuilae* recorded in San Diego County in the years 1923–38, inclusive:

	L. h. humilis	*L. h. cahuilae*	*Total*
January	4		4
February	4		4
March	4		4
April	7	2	9
May	17	12	29
June	19	1	20
July	13	2	15
August	9	1	10
September	5	1	6
October	2		2
November	2		2
December	2	1	3
	88	20	108

These two subspecies accounted for 0.83 per cent of the total of 12,947 snakes of all species recorded from this area during this period. Of course, I do not suggest that this is an indication of the relative abundance of worm snakes compared to other species, for they naturally suffer, in statistics of this kind, because of their small size, and nocturnal and secretive habits. It is quite probable that *Leptotyphlops* is one of the most plentiful snakes in the area.

The zonal distribution of these 108 specimens was as follows: coast, 38; inland valleys and mesas, 15; foothills, 25; mountains, 2; desert foothills, 26; desert, 2. The snakes in the last two zones were either *humilis-cahuilae* intergrades or *cahuilae;* the others were all *humilis humilis.*

Burt (1935, p. 327) observed *dissectus* crossing a sidewalk just after dark, evidently bound for moist sandy soil in an iris bed. Another was collected by a student at Norman, Okla., on a sidewalk at 9:30 P. M., temperature 92° F. Major Chapman Grant observed *humilis humilis* crawling above ground in the dark of early evening. While they seem to prefer the dark of the moon, *cahuilae* has been found out on the road in full moon. Mosauer (1936, p. 10) observed 5 specimens of *cahuilae* in three evenings in the sandhills of the Vizcaíno Desert. He found four by following their tracks. He states that they emerge at, or shortly after, nightfall. In the sand they use the undulatory type of locomotion; the sharp point of the tail makes the track identification easy. They travel on the surface in sand, not just below as does *Chilomeniscus.* The tracks showed signs of sideslip, for these snakes are not as well adapted for sand as they are for crevices and passages below ground. Most sand-inhabiting forms are flattened ventrally, but *Leptotyphlops* is not.

In captivity worm snakes are observed to use the tail spine as an aid to motion, especially when placed on a hard surface. When dropped on loose or sandy soil they burrow immediately. They are never peaceful or quiet when above ground in the light, but actively search for something into which to burrow, or to hide under; they are therefore difficult to photograph. The worm snake uses its tongue to sense the surroundings.

I have observed in the shed skin of *humilis* that the imbrications, or folding-over of the scales, are present as in the live snake.

The food probably consists of termites and similar soft-bodied insects. Miss Force observed *dissectus* to eat ant eggs in captivity, but not readily. Mosauer saw *cahuilae* drink in captivity but not eat.

The hemipenes of *dulcis dulcis* are unbifurcated, smooth, and deeply grooved to the ends, by a single, ridged sulcus.

Most of the females captured in the early summer are carrying well-developed eggs. It is presumed that they are laid in the late summer, as is the case with our other southwestern oviparous snakes. Miss Force noted a specimen of *dissectus* 225 mm. long with 7 large developing eggs, and other smaller eggs. Specimens 193 and 195 mm. long contained eggs. These were Oklahoma specimens.

Humilis is a larger snake. I have not observed a female less than 245 mm. long with eggs. The following are some records of the eggs in specimens of *humilis-cahuilae* intergrades from the Sentenac Canyon area, the first figure giving the length of the snake in mm., the next, in parenthesis, the number of eggs: 248 (3), 250 (3), 256 (2), 267 (4), 281 (6), 290 (2), 294 (4), 321 (6), 340 (6). The average number of eggs is 4. A correlation is apparent between size and number of eggs; the correlation coefficient was calculated and found to be $r = +0.716$. By the *t*-test this is proved significant ($P = 0.03$). Thus the larger specimens are likely to have more young, as was found to be the case with the rattlesnakes (Occ. Papers S. D. Soc. Nat. Hist., No. 1, p. 14).

The eggs are long and thin, as might be expected in so attenuated a creature. Measurements were made on those contained in a *humilis* and were found to be about 15 x 4½ mm. The young at birth are about one-third of maximum adult size.

These little snakes, being without means of defence except concealment, must be the prey of any animals that can find them. A specimen of *dulcis* was found dead at the base of an owl's nest by A. J. Kirn. The remains of a specimen of *humilis* were found in coyote scat by Howard Twining at Gibralter Dam near Santa Barbara, California. A specimen of *segregus* (Corn. U. 1670), from 15 miles southwest of Marathon, Brewster County, Texas, was removed from the stomach of a curve-billed thrasher. Another of the same subspecies (U. Mich. 65,381 from near Phantom Lake, Texas) was found crushed in a cow track. I have already stated that many are destroyed by automobiles as they cross the road at night.

Earl Sanders noted a specimen of *humilis* near Mesa, Arizona, with its tail caught in the web of a black-widow spider. It was struggling unsuccessfully to escape. This snake was 150 mm. long.

TABULAR SUMMARY OF SPECIFIC AND SUBSPECIFIC CHARACTERS

SUBSPECIES	*Dulcis*	*Myopicus*	*Dissectus*	*Maximus*	*Bressoni**	*Humilis†*	*Dugesii*	*Slevini*	*Cahuilae‡*	*Utahensis*	*Segregus§*	*Tenuiculus**
Presence of supraoculars	+	+	+	+	+	—	—	—	—	—	—	—
Division of anterior supralabials	—	+	+	—	+	—	—	—	—	—	—	—
Scale rows around tail	10	10	10	12	10	12	12	12	12	12	10	10
Dorsals, mean	228	213	238	224	240	272	242	253	295	300	271	244
Dorsals, minimum	206	199	224	216	—	257	235	244	280	289	261	—
Dorsals, maximum	255	222‖	246	235	—	283	257	269	305	308	275	—
Subcaudals, mean	14.6	14.1	13.9	14.3	12	17.9	17	15	17.4	18.0	14.0	14
Subcaudals, range	12–17	11–17	12–16	13–16	—	15–21	—	12–18	16–21	17–20	12–16	—
Usual approximate order of size of the first four mid-dorsal head scales (increasing to the right)	2–4–1–3	1–2–3–4	1–2–4–3	1–2–3–4	1–2–4–3	1–2–4–3	1–2–3–4	Equal	1–2–4–3	1–2–3–4	2–1–3–4	—
Body length/diameter, mean	50	54	51	45	55	55	48	49	60	63	58	47
Body length/tail length, mean	19	18	22	19	20	21	19	23	22	22	22	19
Number of pigmented dorsal scale rows	7	7	7	7	7	7	7	5	5	7	7	7
Typical dorsal color (alcoholic specimens)	Medium Brown	M. to D. Brown	Medium Brown	M. to D. Brown	Dark Brown	Dark Brown	Medium Brown	Light Brown	Almost White	Gray Brown	M. to D. Brown	Gray Brown
Longest specimen, mm.	271	227	272	300	265	315	187	253	389	322	319	117

* Description based on type specimen only. † Description based on coastal California specimens. ‡ Omitting intergrades. § Not including Arizona intergrades.
‖ Omitting one Veracruz specimen with 236.

KEY TO THE WORM SNAKES

OF THE GENUS LEPTOTYPHLOPS IN THE UNITED STATES AND MEXICO

Note: I have made no particular study of *L. phenops* Cope, 1875, or *L. bakewelli* Oliver, 1937, the two presently recognized Mexican species allied to *L. albifrons* of South America; for, not belonging to the *dulcis-humilis* group, they are beyond the scope of this paper. Nevertheless it appears desirable to include them in this key, in order to make it territorially complete. They are therefore included without particular study or verification. All colors mentioned in this key are based on preserved specimens.

1 a. With supraoculars 2

1 b. Without supraoculars 8

2 a. Supraoculars much larger than the prefrontal or frontal; a dorsal pattern of dark brown, with distinct longitudinal light lines 3

2 b. Supraoculars no larger, or but little larger, than the prefrontal or frontal; the dorsal pattern, if dark brown, without distinct longitudinal light lines 4

3 a. Rostral contacting the supraoculars *L. bakewelli*
Colima to eastern Oaxaca, Mexico.

3 b. Rostral not contacting the supraoculars *L. phenops*
Yucatan to Chiapas and Oaxaca; also central Veracruz, Mexico.

4 a. Twelve scale rows around the tail *L. maximus*
Guerrero and Morelos, Mexico.

4 b. Ten scale rows around the tail 5

5 a. Anterior supralabials entire *L. d. dulcis*
Central Oklahoma south through central Texas to northern Nuevo León and Tamaulipas.

5 b. Each anterior supralabial divided by a vertical suture 6

6 a. Parietals not contacting the posterior supralabials *L. bressoni*
At present known only from the type locality, Uruapan, Michoacán, Mexico.

6 b. Parietals contacting the posterior supralabials 7

7 a. Dorsal scales number 224 or more *L. d. dissectus*
Coahuila, trans-Pecos Texas, southern New Mexico and southeastern Arizona; also southern Kansas, central and northeastern Oklahoma.

7 b. Fewer than 224 dorsals *L. d. myopicus*
Northern Veracruz, San Luis Potosí, southern Tamaulipas, and southern and central Nuevo León, Mexico.

8 a. Ten scale rows around the tail 9

8 b. Twelve scale rows around the tail 10

9 a. Dorsal scales number 250 or more *L. h. segregus*
Southeastern Arizona through trans-Pecos and Big Bend Texas, to central Coahuila.

9 b. Dorsal scales number less than 250 *L. h. tenuiculus*
San Luis Potosí, Mexico.

10 a. Fourth mid-dorsal scale (interoccipital) often divided longitudinally; fifth dorsal much wider than the sixth; dorsal scales exceed 288 *L. h. utahensis*
Extreme southwestern Utah.

10 b. Fourth mid-dorsal scale undivided; fifth dorsal not much, if any, wider than the sixth; dorsal scales more or less than 288 11

11 a. Dorsal scales usually below 260 12

11 b. Dorsal scales usually 260 or more 13

12 a. Five pigmented dorsal scale rows; usually 244 or more dorsal scales *L. h. slevini*
Cape Region of Baja California, Mexico.

12 b. Seven pigmented dorsal scale rows; usually less than 244 dorsal scales *L. h. dugesii*
Sinaloa southeast to Colima; Guanajuato, Mexico.

13 a. Five lightly pigmented dorsal scale rows; usually 285 or more dorsal scales *L. h. cahuilae*
The Colorado Desert in southeastern California, the Yuma Desert in southwestern Arizona, and Vizcaíno Desert in central Baja California.

13 b. Seven or more heavily pigmented dorsal scale rows; usually less than 285 dorsal scales *L. h. humilis*
Central Baja California north to Santa Barbara, California; the Mojave Desert; from extreme southern Nevada southeasterly to the Tucson area in Arizona; Cedros Island.

MUSEUM ABBREVIATIONS

In referring to specimens by number the following abbreviations have been used:

ANSP	Academy of Natural Sciences of Philadelphia
BYU	Brigham Young University
CAS	California Academy of Sciences
Corn. U.	Cornell University
EHT-HMS	Private collection of E. H. Taylor and H. M. Smith
FMNH	Field Museum of Natural History
LMK	Private collection of L. M. Klauber
MCZ	Museum of Comparative Zoölogy, Harvard University
U. Mich.	Museum of Zoölogy, University of Michigan
U. Okla.	University of Oklahoma
USNM	United States National Museum

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SUMMARY AND CONCLUSIONS

In North America there are three groups of worm snakes of the genus *Leptotyphlops*. One comprises species allied to *L. albifrons*, a South American form. This group, being primarily Neotropical, is omitted from the present discussion. The other two, the *dulcis* and *humilis* groups, are differentiated from each other by the presence or absence of supraoculars. The former includes three species, with a total of five subspecies. One subspecies now revived, is Cope's *dissectus*, long synonymized with *myopicus*, which in turn is shown to be a subspecies of *dulcis*.

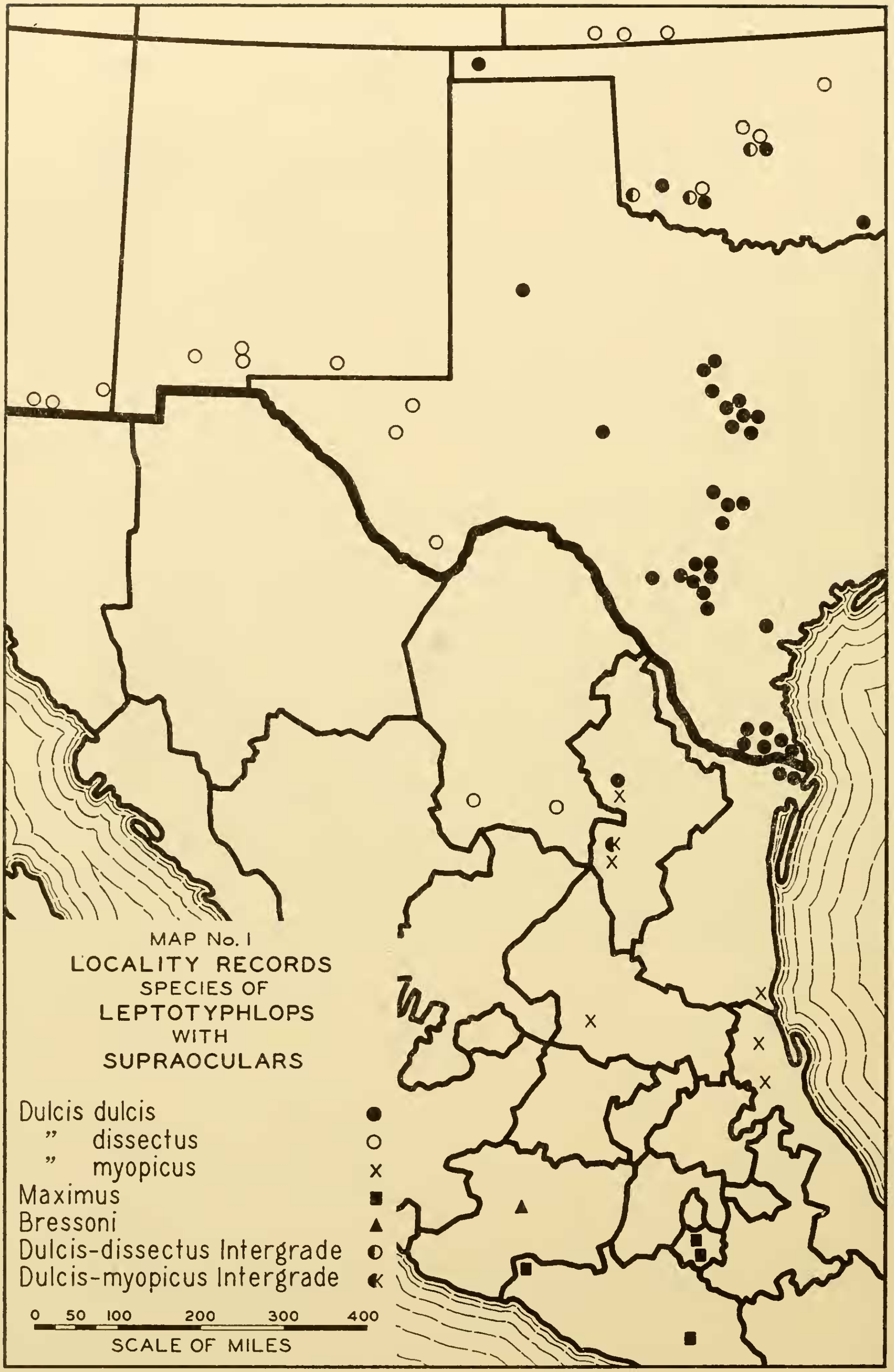
The *humilis* group comprises 7 subspecies, *dugesii* of Bocourt and *tenuiculus* of Garman being revived. Some of the taxonomic conclusions respecting Mexican forms are tentative because of a lack of adequate material.

All forms are described in full. Intrasubspecific variations and subspecific relationships are discussed. Life history notes are presented.

The survey involves a general consideration and evaluation of differential characters in the genus. The number of scale rows around the tail, possibly a novel character, is found useful. The coefficients of variation of several characters in homogeneous series are derived. The limitations of body proportionalities are pointed out. It is found that worm snakes become somewhat thicker-bodied as they age. Differences in scale arrangements and configurations are found of value in taxonomy, but aberrants are not infrequent. Special arrangements and aberrances are peculiarly repetitive in species not closely related.

Although the forms discussed inhabit deserts and semi-deserts they prefer moist areas. While secretive and primarily subterranean, they roam above ground at night. Larger females lay a greater number of eggs.

A key to the worm snakes of North America is presented.



MAP No. 1
LOCALITY RECORDS
SPECIES OF
LEPTOTYPHLOPS
WITH
SUPRAOCULARS

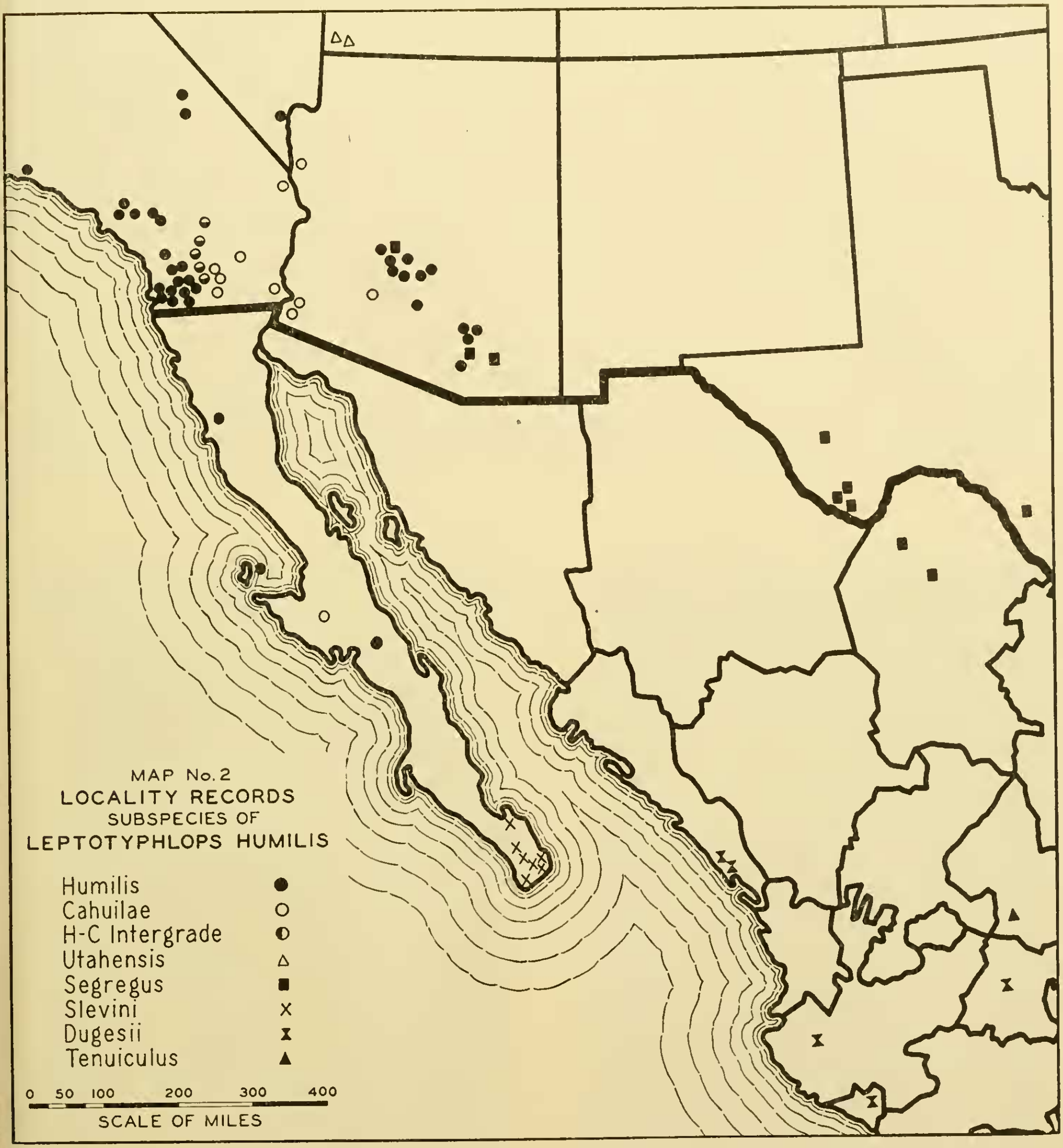

MAP No. 2
LOCALITY RECORDS
SUBSPECIES OF
LEPTOTYPHLOPS HUMILIS
Humilis ●
Cahuilae ○
H-C Intergrade ◐
Utahensis △
Segregus ■
Slevini ×
Dugesii ⧗
Tenuiculus ▲
0 50 100 200 300 400
SCALE OF MILES

PLATE 6

Fig. 1. Dorsal view of *Leptotyphlops humilis humilis* (× 1.6). Head at the left.

Fig. 2. Dorsal view of head of *Leptotyphlops humilis humilis* (× 24).

Fig. 3. Lateral view of tail of *Leptotyphlops humilis humilis,* showing terminal spine (× 24).

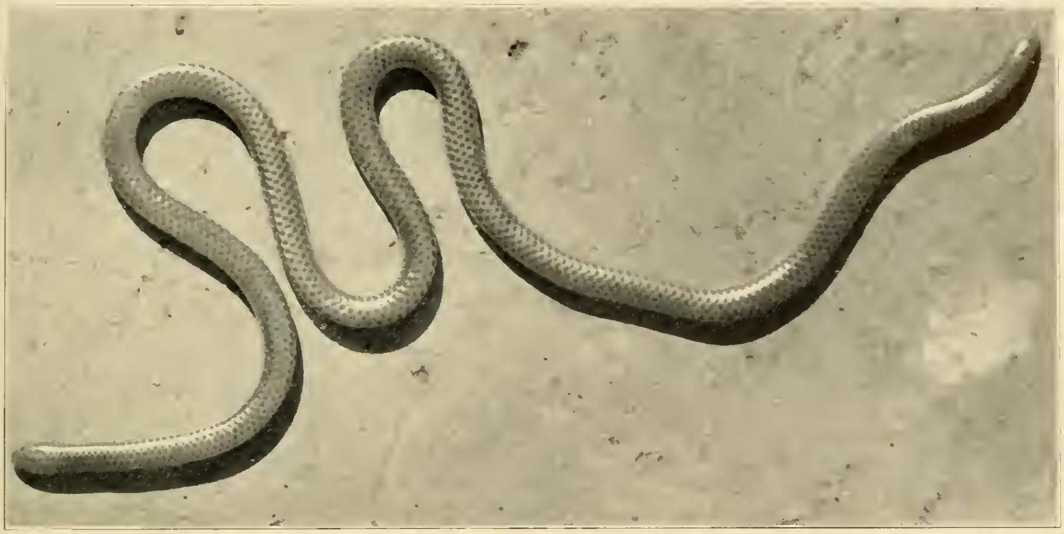


Fig. 1.

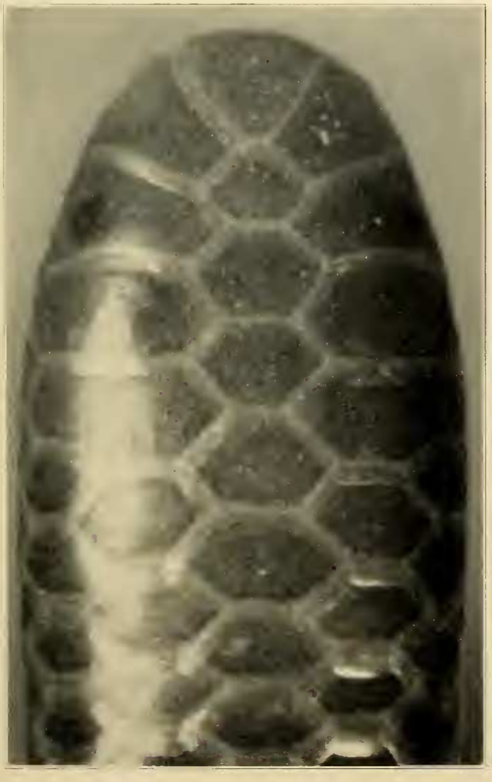


Fig. 2.

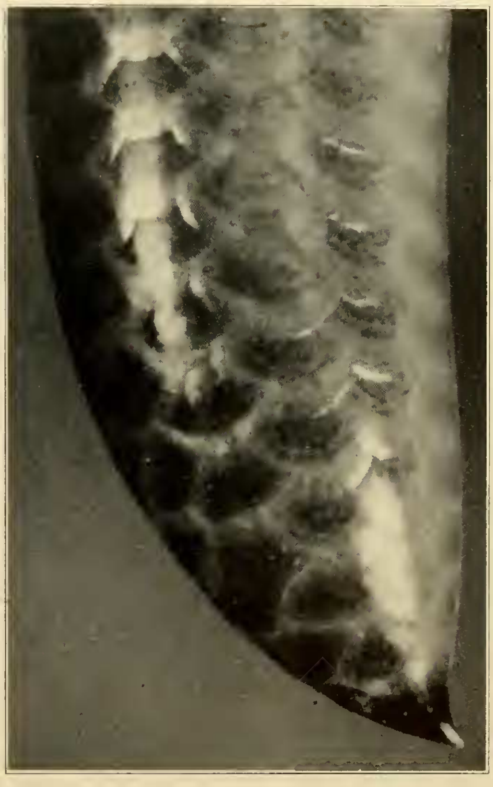


Fig. 3.